

THE
FIELD ENGINEER;

OR
INSTRUCTIONS UPON EVERY BRANCH

OF
FIELD FORTIFICATION:

Demonstrated by Examples which occurred in the Seven Years War

BETWEEN THE
PRUSSIANS, the *AUSTRIANS*, and the
RUSSIANS;

WITH PLANS AND EXPLANATORY NOTES.

Translated from the *Fourth Edition* of the GERMAN ORIGINAL of

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THE
FIELD ENGINEER.

PART II.

CHAPTER XIII.

*Of Parapets, Fleches, Redouts, Star-Forts,
and other Works.*

§ 351. **A**S I have now explained the rules which are to be attended to in marking out retrenchments, in estimating their extent, and in constructing the different field-works; their use, advantage, and disadvantage, will be the more easily understood.

OF PARAPETS.

EVERY work consists of a breastwork or parapet and a ditch.—The ditch is in-

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B

tended

tended to keep off the enemy, while the parapet defends your troops against the fire of his artillery or small arms: Consequently, whenever the Engineers begin the foundation of a work, they ought to be aware of the number and weight of the cannon with which there is a probability of its being attacked, and to carry in their minds what I have before observed, viz. that a shot from *one* to *four* pounds weight will penetrate good earth to the depth of four or five feet: that a shot of *six* or *eight* pounds will penetrate from *six* to *seven* feet: that a shot of *twelve* pounds will penetrate from *eight* to *nine* feet: and that a shot of *twenty-four* pounds will penetrate even to the depth of *fifteen* or *sixteen* feet.

§ 352. PARAPETS are generally four feet and a half above the banquette; and (as it seldom happens that soldiers measure more than five feet ten or eleven inches) they would be altogether useless if their height was increased; and perhaps a deduction

duction of ten or twelve inches might make them still more convenient. For, in the first place, many short men cannot hit the enemy when he has gained the ditch, or is even within a few paces of it; while those who are taller will seldom stand upright, that they may be the better defended, and fire into the air. And 2dly, the more a soldier is in the habit of being covered, the more he will require: for I am persuaded, that if the generality of them had a parapet as high as their chins, they would soon feel a degree of dissatisfaction at not being totally concealed.—If the half of a man's body is defended, he ought to think himself sufficiently secure, and he will then have the following advantages over his enemy, which are by no means inconsiderable. Let the height of the parapet be what it may, the enemy must be exposed during the attack, and the ground upon which he stands will be lower than the banquette. (§ 259). Therefore the fire of his musketry cannot have its full effect, according to the principle

which I have before laid down in the 253^d paragraph ; and if, instead of firing, he only attempts to march expeditiously up to the work with a view of taking it by storm, its lowness will not be detrimental : provided the ditch is of sufficient depth.— Hence it is evident, that such a parapet cannot counteract the great advantage which is to be derived from every field-work, viz. that of keeping off your enemy.

In what I have hitherto said, I am of course confining myself to the interior height of the parapet above the banquette; and I only mean it to be understood, that a proportionable number of banquettes should be added, whenever it may be advisable to raise the work more than usual. As long as the enemy is at a distance from your work, the whole of the defenders cannot be wanted at the parapet, and when he is near to it, your troops may stand upon the upper banquette, without being exposed to the fire of artillery : for, at that time, he will not be able to make use
of

of cannon, for fear of destroying his own men.

§ 353. I HAVE already observed, that the ditch is intended to keep off the enemy ; consequently it ought to be in front of the parapet : except when the height of the situation, a river, a morass, or some other obstacle, should make an approach to it either impracticable or extremely difficult.

§ 354. THE ditch must be of such breadth that the enemy shall neither be able to leap over it on foot nor on horseback ; and, by its depth, you must endeavour to obstruct his ascent of the scarp as much as possible, even if he should have had the courage to get into it.

§ 355. EPAULEMENTS may be ranked under the head of parapets ; and although they are principally formed with a view of covering the cavalry, yet there are some

cases, especially during the attack of a fortress, wherein they may be equally serviceable to the infantry.—They are not intended to keep off the enemy, but merely to resist his shot. Consequently, they must be of sufficient strength, from eight to twelve feet in height, as circumstances may require, and their ditches may be made either in their front or rear. Whenever they are to be occupied by infantry, (as in Pl. 24 and 25) two or three banquettes will be required; and if their ditches are in front, an excellent horizontal fire may be gained from thence.

§ 356. WHEN a parapet is formed in a straight line (as at *a b*, Pl. 14. fig. 4), it can only present a front fire; and of course its defence would be too weak, unless it was strengthened by salient and reentrant angles.

OF FLECHES*.

§ 357. FROM what I have said in the foregoing paragraph, it must be evident that those fleches which are not flanked by any other work, will be still weaker than a straight parapet. Because they can only present a single fire, and are at the same time totally exposed at their salient angles.—Pl. 14. fig. 1, *a b c* †.

§ 358. BUT if they are placed within musket-shot, so as to flank each other, they will be serviceable in covering the front of a line, and may be considerably improved by the addition of two small

* See Vol. VI. Chapters XI. and XVIII.—*Author*.

† An *undefended angle* in fortification is generally understood to be the exposed part, *i e b*, in Pl. 4. fig. 1; and *a c b* in Pl. 14. fig. 1: but a *dead angle* is properly that part of the ditch in front of a reentrant angle, which cannot be raked by any other line, and which is not even visible from the parapet, when there is a high rampart; of course it then becomes still more dangerous on account of the enemy's miners. Pl. 17. fig. 3, *b*.—These subjects, however, will be more fully explained in the third Volume and third Section of my ACCOUNT of the WAR, &c.—*Author*.

flanks (as at *a a*, fig. 2). In some cases it may be also advantageous to cut off their salient angles, as in fig. 3, *d*; by which means they will be in great measure defended.

§ 359. IF fleches are thrown up in front of a straight line, or joined together by a curtain, as in fig. 4, their defence will be weak: but that fault may be easily corrected if you allow the centre of the curtain to project. (Fig. 5, *b*).—Because, in that case, a species of indented line will be formed, which is always preferable to any other.—In the 10th Chapter, and 319th paragraph, I have shown how they are to be drawn and marked out,

§ 360. IN general it is not advisable that fleches should be enclosed in the rear, lest the enemy should be defended against your fire when he has taken possession of them. And if it should be thought necessary to enclose the gorges of such as lie in the front, that the enemy may not march
round

round and take them in the rear, strong palisades ought to be made use of for that purpose: because, in all probability, they will not be carried till you have had time to send a reinforcement to their relief; and if they should not hold out so long, the palisades will afford him no defence against the fire of your cannon; but, on the contrary, they will increase the effect of every shot. Pl. 14, fig. 1 and 7.

§ 361. WHEN cannon are brought into a fleche, their position need not be confined to any particular part of it. In general, however, they are either placed as at *a* in fig. 2 and 5, for the purpose of defending the ditch; at the salient angles *d* in fig. 3, and *d c* in fig. 4; behind the curtain *e e* in fig. 4, and fig. 5 *b*; or at the fortie *c* in fig. 5.

Whenever fleches or other works are joined together, their entrances are usually made at the reentrant angles, particularly when they can be well defended by a cross fire, and covered by traverses, as in fig. 5 and

7. — But if the curtains are formed in a straight line, they may be in the centre, and covered by small fleches, fig. 6, *a b*. In which case, and indeed whenever there are detached works in front of a line, the ends of their ditches should be sloped off as at *a b*, in fig 6 ; otherwise it would be impossible to fire upon the enemy from the parapet *c d* after he had got into them.

§ 362. WHEN a communication is to be kept up between the main line and the detached works in its front, it may be effected, either by means of two rows of palisades (*d* fig. 1, Pl. 14) or by a double parapet, as at *c e* in fig. 3.—These communications however are generally better in theory than in practice. For although it would appear to be right, and merely consistent with every idea of humanity, that your troops, who have made an obstinate and brave resistance, should be able to retreat in security : yet the unavoidable confusion upon such occasions, and the probability that the enemy might force his way

way into your lines at the same time, render it frequently necessary to abandon them to their fate, and to begin a heavy fire of grape-shot for your own preservation.

In this manner General Laudon took possession of Glatz; and the same accident was narrowly avoided at Dresden, in the year 1758, when the Austrians repulsed the Prussian advanced posts from the Great-Garden.

O F R E D O U T S *.

§ 363. NOTWITHSTANDING redouts are generally made use of in the field, they are as imperfect as fleches, if undefended by other works; and their salient angles will always be as much exposed: especially if you cannot bring artillery into them.—M. de Clairac has endeavoured to repair this imperfection by means of a *cremaille*, but his attempts have not been altogether suc-

* See *Quadrangular-works*, Vol. VI. Chap. XI.—*Author*.

cessful,

cessful, as I have shown in the 3d Sect. and 3d Vol. of my ACCOUNT *of the WAR*, &c.

For my own part, I would not make use of cremailles on any occasion: but, as they are now in considerable repute, I have added them to the 1st figure in the 15th plan. —Whenever a cremaille is to be formed, pickets are driven into the ground about a foot asunder, and wattled with twigs or pliant branches of trees. And the pickets which are made use of for that purpose, are four feet and a half above the earth, or of equal height with the parapet.

§ 364. IN the 15th plan I have endeavoured to explain every good alteration which can be made in the construction of a redout *.

* I have here omitted a few lines of the original, which contained an apology, on the part of the Author, for having been compelled, by the smallness of his plan, to disregard the general rules of proportion in several parts of it. My plan is drawn on an increased scale, that all its parts might have their proper dimensions; and my additional profiles *g h* will show the difference between the two finished sides of the redout, as well as the appearance of the fraises and palisades when placed: which could not have been so well expressed in any other manner.

Translator,

L L,

L L, in fig. 2, represent the method of marking out the slope of the first banquette; *k k*, *i i*, its breadth; *i i*, *b b*, the basis of the slope of the second banquette; and *b b*, *g g* its breadth.—In fig. 1, *b b*, *g g*, represent the slope of the first and only banquette. To form the *cremaille*, pickets are driven along the line *f f*, six feet asunder, and from each of them, lines are drawn parallel to *m i*, and to the base *d k*. The teeth or salient angles of the *cremaille* will enter three or four feet into the parapet; therefore it must be strengthened in proportion, and its usual interior talus rejected.—In the 2d figure, *g g*, *f f*, mark the basis of the interior talus of the parapet; *f f*, *e e*, its breadth; and *e e*, *a a*, its exterior talus.—If there is no berm, *a a*, *b b*, show the interior slope or scarp of the ditch, and the magistral line, or line of horizon, becomes invisible as soon as the work is finished: because the exterior talus of the parapet and the scarp of the ditch form an uninterrupted descent. When a berm is made, it extends from the
line

line of horizon outwards, and is generally from two to four feet in breadth. In that case, the interior talus of the ditch will begin at the edge of the berm. *B b*, *c c*, mark the breadth of the bottom of the ditch; *a a*, *m m*, its breadth at the top; *b b*, *a a*, its interior talus or scarp; and *c c*, *m m*, its exterior talus or counterscarp.—Whenever a glacis is formed, the counterscarp *c m* is a little elevated, and of course the ditch receives an addition to its depth. This is shown by *m d*, and the extent of the glacis by the letters *d r*.—The height and slope of a glacis are generally regulated by carrying an imaginary line in the direction of the superior talus of the parapet*.

I have made one embrasure at the fide *r*, and another at the salient angle *s*. The last, however, is but rarely found; because, when it is necessary to have cannon at the angles, it is usual to fire over the parapet. The platforms *u* and *v* are formed for that purpose.

* See my additional profiles *g h*.—*Translator*.

o represents the beam upon which the fraises are nailed; *p*, that with which they are fixed within the parapet; and *q*, their appearance when the whole is finished.—*w* shows the best position of the palifades when in one row, and *x* their best position when in two rows.—*y* in fig. 1, and *z z* in fig. 2, represent the workmen.

§ 365. IN consequence of the weak defence of every salient angle, one of the sides of a redout ought always to be opposite to the object, which it is either intended to fire upon or to defend: except when its parapet is formed *en cremaille*. In that case, an angle may be advanced and occupied by a cannon.—The entrance should be covered either by a traverse, chevaux-de-frise, or palifades; and a tambour may be formed within the work, to enable you to make a second defence after the enemy has gained the parapet.—But I am afraid this will seldom be of much service.

Whenever redouts are thrown up in front of a line or position, their rear sides ought

ought only to be enclosed with strong palisades (*a c b*, Pl. 14. fig. 7), for the reasons that I have already had occasion to give in the 360th paragraph*, and if a ditch is made on the outside of them, to give the enemy greater difficulty in taking possession of the works, the earth must either be carried away or spread upon the ground.

§ 366. REDOUTS, as well as fleches, may be joined together with a curtain, for the formation of a line or retrenchment; and if they are not within shot of each other, its centre should form a salient angle, as in fig. 7. Pl. 14: or a fleche may be added, as in fig. 6, to give a more rectangular defence. In either case, the rear lines of the redouts ought to be made according to the method which has been recommended in the last paragraph, or upon a very weak profile. Such a retrenchment will have one peculiar advantage, viz. that of obliging the enemy to make a fresh at-

* See Vol. VI. Chap. XVIII.—*Author.*

tack upon every redout, even if he should have forced his way through any part of the curtain.

§ 367. No retrenchments are so good as those formed by redouts, which flank and support each other, with fleches and single parapets between them, as in Plans 24 and 28.—Because your troops can then manœuvre with freedom, or advance to the attack whenever a favourable opportunity may offer; and, if the enemy should break through the fleches in front, the second chain of works will probably oblige him to make a precipitate retreat.—But I shall say more upon this subject in the 25th Chapter.

OF THE TENAILLE.

§ 368. As this work flanks itself and has a cross fire in the front, its defence is undoubtedly preferable either to that of a fleche or a redout: I am therefore at a loss

to imagine why the Engineers do not make more frequent use of it.—Fig. 8, in the 14th Plan, is a reversed tenaille; and the extent of the angle c is in great measure discretionary: that is to say, it may have from 90° to 150° . However, if it is too obtuse, the cross fire becomes imperfect, and if it has less than 90° , the defenders will be in danger of wounding each other.

§ 369. THIS tenaille may also have flanks as in fig. 9, and the direction of them may be either similar to ad or be : as the ground and other circumstances may seem to recommend.—If the flanks are not exposed to the enemy's fire, but only added to prevent their being taken in the rear, they ought to be formed upon a very weak profile, or merely with palisades: which method I also recommend whenever their gorges are to be enclosed, as shown by de^* .

If a fortie is necessary, it may be made

* See Vol. VI. Chap. XII.—*Author*.

in the reentrant angle, or through the palisades *da*.—In the first case it should be covered by a traverse, and in the second by a chevaux-de-frise.

OF THE STAR-FORT.

§ 370. STAR-FORTS are at present not much in use, because it has been found by experience that they are weak, especially those of a square or pentagonal form, and that their interior space is too small.—The hexagon, however, is still used for the purpose of covering single posts, particularly when they occupy heights; it admits of the best defence, and may be made with flanks and curtains, according to the regular rules of fortification, (Pl. 16. fig. 1). The lines of defence are found by drawing together the points *ac*, *ce*, *bd*, *df*, &c.; from the points of intersection of these lines, *six* toises or *thirty-six* feet are carried along them to *ik*, and *three* toises or *eighteen* feet to *lm*. Consequently, *ki*

and *lm* give the flanks and curtain; *ia* and *kb* the faces of the bastions *.

The methods of marking out this figure upon the ground have been already explained in the 312th paragraph.

OF IRREGULAR WORKS.

§ 371. As these works are at all times regulated according to the nature of the ground on which they are situated, they are the most in use; and wherever nothing is to be apprehended from the enemy's artillery, they may be formed entirely with palisades.—But this subject will come more particularly under our consideration in the 25th Chapter.

* See *Star-Forts*, Vol. VI. Chap. XII. and XIII.—*Author*.

CHAPTER XIV.

Of Têtes-de-Pont..*

§ 372. **T**ETES-DE-PONT must be placed wherever they will defend the bridges most effectually from the enemy's artillery, and there must be a sufficient space in their rear to allow the troops to move with ease after they have passed the river, and to march through with the utmost regularity.—During a retreat, the same objects are to be attended to. If you can establish your tête-de-pont where the river forms a curve, you will be able to gain more room within the work than in any other situation, and to flank it effectually from the opposite shore.—Pl. 17. fig. 2.

§ 373. IF small arms will carry across the river, a parapet may be thrown up as shown

* The attack and defence of these works will be found in the sixth Vol. of my ACCOUNT of the WAR, &c. Chap. XIX.
Author.

by *cd*, in fig. 2; by which means you will be enabled to support the tête-de-pont, in case of an attack; and, at the same time, to fire upon the enemy, if he should take possession of the work.—But if the river is 300 or even 250 paces in breadth, or if the ground is very low between your position and the water, musketry will be of little service.—In that case, it would be advisable to form batteries as at *a*, before you venture to march down to the bridge.

It is also of the greatest advantage that the flanks should be defended by fleches or redouts, whose rear sides are either enclosed with palisades or a weak parapet (fig. 2, *b*): that the enemy's cavalry may not take possession of them, although they may be sent over the river for that purpose.

In all têtes-de-pont the entrances should be large enough to allow your troops to march expeditiously through them, and defended by traverses or chevaux-de-frise.

§ 374. WHENEVER the time will admit of it, no pains should be spared in the construction of a tête-de-pont: because every thing must depend upon its strength and durability.

Têtes-de-pont may be formed under two circumstances: First, when you have no cause to be apprehensive of an attack, and are in possession of both the banks of the river: and 2dly, while you are throwing over your bridges in sight of the enemy.— In the last instance, I believe, no better rules can be observed than those which I have given in the 5th Chapter.

§ 375. EVERY tête-de-pont must be left open towards the water, that the enemy may be totally exposed to the fire of our batteries on the opposite shore, in case he should take possession of them.

§ 376. WHENEVER a tête-de-pont is thrown up at the end of an old bridge, near a town or post, it is not done so much with a view of facilitating the passage of your

troops, as of preserving a safe communication between the two shores.—Therefore the interior space may be smaller than is usual in other cases, and one pass thro' it will be fully sufficient. In general its size will be regulated according to the number of men intended for its defence.

§ 377. NOTWITHSTANDING several *têtes-de-pont* are contained in the latter part of the 10th Chapter, I shall add others here, with a more particular account of their construction and use.

To form the second figure in the 16th Plan, which I have taken from M. de Clairac, you must mark out a square or parallelogram of the intended size of your figure. (Here the length is fifty toises and the breadth sixty, or three hundred and sixty feet.) Let its sides be divided into four equal parts. A *c* is one-fourth of the side *ab*; and at *c*, a line is drawn parallel to *af*. Upon this line you must mark off one-fourth of its whole length from *c* to *d*, and the same on the other side. The
points

points *d* and *e* show where the flanks of the bastions will commence; as well as the length of the curtain.—Then draw the lines of defence *a e*, *f d*, and the perpendiculars which are raised on them at *d* and *e* will give you the points *g b*, by their intersection of the lines of defence.—Consequently *d g*, *e b* will be the flanks, and *g a*, *b f* the faces of the bastions.—To regulate the sides you must set off from *c* towards *d* one-sixth of that line; and draw your chain from *a* through that point towards *k*, till you find yourself opposite the picket which marks the third quarter of the side *a b*; and at that point *k*, you must set off an angle of 120° , and draw *k m* to the bank of the river, or as far as may be necessary. I have here added a covert-way, but the work may be formed either with or without it: and if it is intended that an army shall pass through, two entrances should be made, one at *k* and the other at *m*, and defended by traverses: that the march may not be retarded.

§ 378. THE first figure in the 17th Plan may be formed in the following manner :

Let the salient angle $b a c$ have 120° , and its sides the length required. From the point a describe an arc through b, d , and c^* , and draw a line from c to a , and another from b to a : divide the side $a b$ into two equal parts, and with the length of one of those parts describe a semicircle from the point e , through the lines $b d$ and $d a$.—Draw the lines of defence from a and b to ff , and at their points of intersection eight toises or forty-eight feet must be set off towards $a b$, and four toises or twenty-four feet towards ff .—These points will give you the length of the curtain, as well as the flank and face of each bastion.

Fig. 2, is constructed in the same manner, and the fleche with which I have covered the curtain may either remain or be laid aside.

* You must let fall a perpendicular from a , to mark the centre of this arc at d ; and then draw together the points $b d$ and $d c$: otherwise you will not be able to ascertain the points ff , where the lines of defence are to fall.—This seems to have been omitted in the original.—*Translator*.

§ 379. IF fig. 2 has only one entrance, it may be made in the curtain at *b*. But if a body of troops must march through the work, there ought to be two, as at *i*, *k*, in fig. 1: and in such positions they will be completely defended.—These entrances are of two kinds.

§ 380. WHEN the bank of a river is so low that the water may be brought into the ditch (as shown in Pl. 16, fig. 2, and Pl. 17, fig. 1), a considerable advantage will be gained; and in that case, there must either be draw-bridges at the entrances, or such as can be easily removed.—An embrasure may also be cut in the traverse which covers each entrance.

§ 381. IN all cases it is advantageous to throw up works on that side of the river which is opposite to your tête-de-pont; as well for the purpose of adding to its support as of covering a retreat.—Artillery ought therefore to be used in preference to small arms, notwithstanding the banks may be within musket-shot of each other.

If

If the opposite bank is much higher than the tête-de-pont, sunk batteries should be formed, as at *a* in fig. 2; and if it is lower, the platforms should be considerably raised, that the tête-de-pont may be defended by a cross fire.

§ 382. ONE or two enclosed redouts can give you a command over your tête-de-pont, as well as the bridge itself (fig. 2, *e*), and if they are judiciously placed they may also enable you to rake the ground in their front.

§ 383. If a tête-de-pont is intended to be extremely strong and durable, it may be formed with a regular rampart and covert-way: of which I have given a profile in the 17th plan, fig. 3.—And as it is of the greatest consequence that the construction of the work should give both the musketry and artillery a complete command over the ditch (especially when water cannot be brought into it); the palisades ought not to be placed in its centre, but rather, below

low the scarp or counterscarp: or even in both those situations, if a sufficient quantity of wood can be procured. Because, however unusual it may be to find them in the main ditch of a fortress, I am persuaded they will always add very much to the strength of your works, and, together with the fraises, render them almost inaccessible.

§ 384. *A, b*, in Pl. 17, fig 3, represent the rampart; *c*, the banquette; *c, b, e, f*, the parapet; *m*, the berm; *a l*, the interior, and *f m*, the exterior talus of the rampart; *m n*, the scarp; and *g o*, the counterscarp: under which name the whole covert-way is frequently comprehended.—*G b* mark the covert-way; *b i*, the banquette; *i*, the palisades; *k*, the glacis; and *p*, the *cuvette*; which is frequently made in a dry ditch, as an additional obstacle to the enemy, and for the purpose of carrying off whatever water may spring out of the ground, or discharge itself from a sluice.

CHAPTER XV.

Of Trous-de-loup, Crows-feet, &c.

OF THE TROU - DE - LOUP.

§ 385. **A**TROU - DE - LOUP is either a square or circular hole of six or eight feet in width, by four or five feet in depth, with a picket of about three feet in length driven into the centre of its bottom, and afterwards pointed.

If circular trous-de-loup are to be made, a line is first traced out, to direct the position, of small pickets; which are placed in the ground at proper distances from each other, and circles described round them in the usual manner, with half the length of their intended diameter. The second and third lines (for it seldom happens that more than *three* are wanted) are then traced on each side, parallel to the first, and every hole that is made upon them must be opposite to the heaps of earth which have
† been

been thrown out of those of the middle row.—The spaces which are left between trous-de-loup must always be as large as the holes themselves (Pl. 4, fig. 13, and Pl. 10, fig. 2); except when there may be sufficient time to carry away the earth. In that case, they can be formed close to each other.

Square trous-de-loup must be made by the same rules, and with the same intervals between them.

§ 386. TROUS-DE-LOUP are usually in front of the salient angles of a work, or wherever its defence may be weak, and about seven or eight paces from the counterescarp of the ditch. They may also be formed before the entrances; provided they do not obstruct the free passage of your men.—Their tops must be covered either with weak hurdles or branches of trees, that the enemy may not discover their position till he comes upon them: otherwise their principal advantages will be destroyed; viz. that of creating disorder
or

or delay among his troops, and of keeping them exposed to your fire.

If they are placed as a security for the intervals between detached works, equal care must be taken that they do not confine your own troops and render your cavalry useless.

OF SHORT PICKETS*.

§ 387. SHORT PICKETS, when cut out of hard wood, will always be preferable to *trous-de-loup*; provided they are of different lengths, from one and a half to three feet, of about an inch in thickness, and pointed at the top.—Ten or more rows of them are usually driven into the ground *en echiquier*, and not less than two feet asunder.—Or, if a sufficient number of harrows could be collected, they might be still more serviceable.

As such means of defence can be applied in all cases, I am surprised that they are not

* See Vol. V. Pl. 4.—*Author*.

in more frequent use. For, in the first place, they are not liable to be shot away by artillery : secondly, they are so numerous that the carpenters must be destroyed before they can remove them : and, thirdly, while they retard the progress of the enemy's infantry, throw them into disorder, and effectually impede his cavalry, your own troops are at liberty to march out on any emergency : which, when trous-de-loup have been formed, is not always practicable.

§ 388. THE reasons which I have given in the foregoing paragraph, and the expeditious method of preparing pickets ; are sufficient inducements to me to place them, not only in the intervals between detached works, but upon the declivity of every hill : on which I might be desirous of keeping the enemy under the fire of my batteries. (See § 192).

§ 389. As experience has proved that bat-

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teries,

teries *, when placed in the open field, are more liable to be taken by cavalry than infantry ; I must recommend the use of short pickets on all such occasions, and in most cases, when it is either probable that an unforeseen attack, or the enemy's impetuosity, should prevent our making use of other means for the defence of our front or flanks.

Henry V. King of England, won the battle of Azincourt, in consequence of having defended his crossbow-men with such pickets †.

OF CROWS-FEET.

§ 390. NOTWITHSTANDING we make but little use of crows-feet in the field, there are cases when they might be of much service.—They are pieces of iron with four points of about four inches in length; which are placed in such a man-

* The first kind in the 333d paragraph.—*Author.*

† See the sixth Vol. of Barrow's works.—*Author.*

ner,

ner, that wherever they are thrown, one of them will always remain in a perpendicular direction.

Crows-feet enabled the Romans to gain a complete victory over the Parthians; who came provided with such numbers of horses and camels, that they were likely to overpower every tactical effort, that could be made against them.

OF STURMBALKEN*.

§ 391. I do not intend to include under this name such as are made use of in the defence of a breach; which are hollow and filled with shells: but merely those which are laid on the summit of a height, and rolled down upon the enemy during his ascent, for the purpose of driving him headlong to the bottom.—In some hilly countries the peasants find this an excellent mode of defence, because they are

* These are large cylindrical pieces of timber, for which I do not know of any English or French name.—*Translator.*

easily made, cost nothing, do great mischief, and are not to be escaped.—If one row of them is found to be insufficient, a second and a third may be rolled down afterwards.

§ 392. ANOTHER mode of defending a work is by means of whole trees, or their branches, placed on the outside of the ditch ; as in Pl. 10, fig. 1, E *.—If they are not in the way of our own shot, they tend very much to distress the enemy, and to keep him under our fire in case he should attempt to storm our lines.

C H A P T E R XVI.

Of Fougasses.

§ 393. **N**OTWITHSTANDING the fougasses which are formed before a retrenchment may be much more harmless than is generally imagined, I am

* See Vol. V. Plans 4, 5, and 6.—*Author.*

an advocate for them : because they check the enemy's approach, and if he knows where they are placed, he will either give up every idea of attacking that part of the lines, or proceed with the greatest irregularity and hesitation.—Fougasses are usually laid before salient angles, unflanked faces, in narrow passes, and in ravines, through which the enemy must march : provided they can be protected at the same time by our own artillery.

§ 394. THEY are prepared in the following manner.—Ten, twelve, or fifteen paces from the outward edge of the ditch, square wells are dug in the ground ; whose sides are at least three feet in length, that the men may have room to work in them : Pl. 18, fig. 1, *a b*, and fig. 2, *i k*. —Their depth is usually from six to ten feet : fig. 1, *a c*, and fig. 2, *k l*.—If the soil is loose, their sides must be secured with boards, as in fig. 2, *i k l* ; but in a stiff or clayey soil it is only necessary that the top should have such a security. Before the

boards are used for this purpose, they should be cut into the necessary length, and joined together as shown by fig. 4.—In loose earth the workmen should begin to line the sides as soon as they have dug to the depth of a few feet, and there should not be a space of more than twelve or fourteen inches between the boards (fig. 1, *ef*, *gh*, &c.), and in some cases they must be still closer *.

§ 395. As soon as a well is prepared, the chamber is made on the side nearest the retrenchment (fig. 1, *i*; fig. 2 *b*), and if necessary, lined with boards.—Its width will depend principally upon the size of the box which contains the powder, but in general it is equal to a sixth of the whole depth; and the proportionable quantity of powder will be shown by the following table; which I have taken from the second part of Vauban *DE L'ATTAQUE et de la Defence des Places*.

* Fougasses were much used at the retrenched camp near Buntzlewitz.—See the third Vol. of my “*ACCOUNT of the WAR,*” &c. Pl. 4.—*Author*.

Depth

Depth of the Fougass.	In common earth.		In deep sand.		In mixed soil.		In clay.		In stony or gravelly soil.	
	lb.	oz.	lb.	oz.	lb.	oz.	lb.	oz.	lb.	oz.
Two Feet - - -	—	9½	—	12½	—	12	—	12½	—	14
Three D° - - -	1	13½	2	4	2	5½	2	8	2	12
Four D° - - -	4	6½	5	5½	5	12½	6	—	6	10
Five D° - - -	8	10	10	7½	11	1½	11	12	12	10
Six D° - - -	14	12½	17	14	18	15½	20	—	23	2
Seven D° - - -	22	2½	26	4	26	5½	27	7	31	10
Eight D° - - -	34	6½	42	3	44	5	46	6½	52	9
Nine D° - - -	55	9	67	8	71	10	75	13	88	—
Ten D° - - -	78	9	96	2	100	10	106	4	121	14
Eleven D° - - -	104	12	125	11	132	12	139	13	163	—
Twelve D° - - -	132	10	161	2	170	12	180	4	208	14

D 4

Σ 396.

§ 396. ANOTHER method of finding the necessary charge for the chamber of a fougass is, by ascertaining the cube of its depth; which will show how many cubic feet of earth are to be blown up. For instance; 216 cubic feet will require in common earth 14lb of powder, in a stiff soil 17lb, in mixed earth 18lb, in clay 19lb, and in stony or gravelly soil, 22 lb *.

I have only introduced the above calculation to give a superficial knowledge of the effect of powder in a mine†: for in the present instance much accuracy is never required.

§ 397. THE following methods are also short, and sufficiently accurate.

I. When you have squared the depth of

* These calculations are founded on experience: and it is here supposed that the fougass is six feet deep; because $6 \times 6 = 36 \times 6 = 216$. Therefore, if the well is 12 feet in depth, we shall find by the same rule that 1728 feet of earth must be blown up: and consequently, if 216 ft. : 14 lb. :: 1728 ft. : 112 lb.—*Translator*.

† Belidor has greatly enlarged and improved this branch of military science by his globes of compression.—See the operations on the 1st of September, in the fourth Vol. and third Sect. of my 'ACCOUNT of the WAR, &c.' Pl. 7 and 8.—*Author*.

the

the fougafs or the line of leaft refiftance, lay afide the laft figure, and multiply the refidue again by the fame number. For inftance, we will fuppofe the depth to be 12 feet, which, when multiplied by 12, will give 144; reject the laft 4, multiply 14 by 12, and the product will be 168. Confequently 168 pounds of powder will be required.

Or, 2, you may find the cube of the depth, and allow an ounce and a half of powder to each cubic foot of earth.

§ 398. IN general, the powder-box muft be equal to a ninth of the whole depth of the fougafs; and about an inch from the bottom of one of its fides, there muft be a hole of one inch and a half fquare (as in fig. 5.) to receive a wooden tube. One end of this tube muft project a little beyond the box, while the other terminates in a point near the centre of the charge, that the fire may not fail to take effect.—When this is done, the top muft be pegged down; and if it is probable that the fougafs

gafs will remain long unused, efpecially in a wet foil, the box and auget fhould be entirely covered with pitch or oil-cloth, or enclosed within a thick mat of ftraw. A powder-barrel may alfo be made ufe of for this purpofe, provided the tube can be properly introduced.—When put into the chamber, the box or barrel muft be fixed in its place with wedges or turf; and, if the lower part of the well is not lined with wood, a board muft be placed on the fide next the auget or tube (fig. 6), through which the fauciffon will be conducted.

§ 399. THE fauciffon (fig. 8, *a b*), by which the fire is brought from behind the parapet to the powder-box, ought to be made of coarfe linen or fuftian, one inch and a half or two inches in diameter, and well filled with dry gunpowder.—In general half a pound may be allowed to every foot in length. It muft then be enclosed within a wooden fpout or auget, that it may not be injured by moiifture, and laid about two feet below the furface of the ground :

ground: as shown by fig. 1, *l*, and fig. 2, *a, b, c, d, e, f*, and *g*.—The wood of the auget must not be less than an inch in thickness, and its interior cavity two inches and a half square, as in fig. 8 and 9.—At the end of every half foot, pegs must be driven on each side of the faucisson, that it may remain in the centre, and the part which descends into the chamber must be fixed with extreme care; lest it should afterwards move out of its proper place, (fig. 1, *km*). When this is completed, the top of the auget must be fastened down with pegs, and the gutter in which it is deposited filled up with earth. On these occasions wooden mallets are always used instead of hammers.

§ 400. THAT part of the auget which passes under the parapet, ought to be laid before the earth is thrown up: or, when fougasses are formed in front of an old work, the parapet should be carefully repaired in those places. — In either case, if there is not sufficient time to lay it under
the

the ditch, it may be carried horizontally over it, and supported by strong poles, as shown by the dotted lines *o*, *p*, *q*, in fig. 2. That end of the fauciflon which receives the fire within the work, must also be pegged down to the ground or made fast with heavy stones.

If an auget cannot be procured, the fauciflon may be wrapt up in straw till it has a covering of four or five inches in thickness.

§ 401. THE board which is placed before the chamber, must be fixed in its proper place by means of three or four wooden props, which are usually about two inches longer than the breadth of the well; that they may have a firm hold against the opposite side (fig. 1, *m*): and the auget will require a prop of the same kind, as at *n*.—When the fougafs is filled, the earth should be well rammed down, to augment the effect of its explosion.

§ 402.

§ 402. THE mouth of the fauciflon, (fig. 2, *a*) ought to be eight or nine paces from the parapet, and equally secure against fire and dampness.—With this view the end of the auget may be allowed to project a few inches beyond it, and when the fougass is intended for use, this top or covering should be removed, and some fresh gunpowder scattered over the fauciflon. But the fire need not be communicated till the enemy is within five or six paces of the well.

§ 403. IF all the necessary tools, pegs, wood, &c. are in readiness, four soldiers and two carpenters will be able to finish a fougass in the course of eight or ten hours.

§ 404. WHEN treffle-fougasses are formed, the fauciflons may be joined together at one point, as at *a* in figures 10 and 11. But, if they should not be intended to play at the same time, they may be otherwise conducted, with about two inches of earth between them, as shown by *b* in
fig.

fig. 10; and their ends must be of different lengths, that they may not be in danger of taking fire at the same time.—By these means you will save the labour of cutting through several parts of the parapet.

Whenever a double or treffle-fougafs is formed, the distance between the chambers must not be less than twice the depth of the wells, that the explosion of one may not injure that which is next to it.

§ 405. IN the formation of a treffle-fougafs before a salient angle (as in fig. 10 and 11), it is of great consequence that the point on which the augets are to meet should be equidistant from each chamber.—Here the faucifions will be joined together, and brought in a straight line through the parapet.

§ 406. FOU GASSES are sometimes formed under works for the purpose of destroying them when abandoned: in that case, they must be laid six or seven feet

below the centre of the parapet, before the rampart is built, fig. 12.

When Goettingen was blockaded, in the winter of 1760-1, the French formed lunettes before the salient angles of the glacis, which communicated with the covert-way by means of coffer. When these works were traced out, they drove stakes into the ground close to each other, in the common form of T mines, and covered them with boards and fascines; that they might be formed as the earth was thrown up from the ditch. — Of course they were ready to receive the powder, whenever they might have occasion to make use of them.

CHAPTER XVII.

Of Abbatis.

§ 407. **I**N time of war, no greater abuses are committed than by the unnecessary formation of abbatis.—As they cost the military nothing, the Command-
ing

ing Officers of corps and detachments generally make use of them without the least scruple, as well for the defence of their own troops, as for the purpose of deceiving the enemy; especially when they are desirous of recommending themselves to the immediate notice of their Sovereign, or the Commander in Chief of the army, as prudent and cautious officers. A foldier should be ready to make every effort, even at the expence of his own property, whenever the service of his country may make a demand of it; but he should remember, at the same time, that war is not carried on against the countrymen; and it ought to be an inviolable maxim with him, never to oppress them with wanton injury, even in an enemy's country.—The destruction of wood is a great and permanent evil, and every benefit that can be derived from an abbatis, which we neither can, nor intend, to maintain, are much too inconsiderable to justify it.—I have already endeavoured to prove, that the defence of abbatis is
difficult

difficult and precarious, and that no service whatever can result from them, when unoccupied by troops. Consequently, whenever a General reposes much confidence in them, he will be the more embarrassed, and the probability of his defeat will be augmented.

§ 408. IN the undermentioned cases ab-batis may be of real use.

1st. When woods are included within the position of a corps.

2dly. When you wish to put your advanced posts or other small bodies into a state of defence, or to prevent their being carried off; and,

3dly. When you wish to retard the enemy's march through hollow-ways, ravines, &c. or to make them impassable.

§ 409. IN the first case, that is to say, when an abbatis forms a part of our defence and retrenchment, every expedient must be used to prevent its being opened by the enemy.

The usual method of felling the trees with their tops towards the enemy is evidently erroneous, because a removal of the branches gives him at once a free passage. But if they are allowed to cross each other, these openings cannot be made without difficulty, and of course half the depth of wood will then give you a better defence.

§ 410. IF the wind is not too high, almost all trees may be felled in the position you wish, provided you first chop them to the heart on the side you intend they should fall, and afterwards begin on the other about four or five inches higher: and, whenever they lean in a contrary direction, two or three men will be able to pull them down.—If the trees are young, you ought not to cut through their stems, that they may preserve a strong hold upon the remaining stumps.

§ 411. THE principal care in the formation of an abbatis is to give it as much defence

fence as possible, otherwise the enemy will drive you from it and force his way thro'.

—This may be done in two ways.

(1). If an abbatis is intended to do the service of a parapet with salient and reentrant angles, you can give them whatever direction the nature of the ground may seem to require, and the trunks of the trees must be carefully placed on the inside. If they are laid lengthwise, the branches within must be cut off, and formed into a glacis on the outside of the work, but if they are otherwise placed, this is unnecessary. Fig. 1 and 2, in Pl. 19, represent the abbatis which were used by the French at their camp near Gandershayn, in 1761. As these are generally higher than other parapets, two or three banquettes will be required; the batteries must be equally elevated, as at *a* in fig. 2; and the trunks must have a covering of earth of eighteen inches or two feet in depth (fig. 1, *b*), otherwise the splinters, which are occasioned by a cannonade, will destroy your own men.

§ 412. IN most cases an abbatis should be placed within rather than on the outside of a wood; because, if the trees stand thick in its front, they not only secure it from a cannonade, but at the same time impede the enemy's manœuvres.—Near the abbatis the trees may be cut down three or four feet above the ground, as in fig. 2, *b*, and fig. 3, *a*; by which means the enemy will be exposed to your fire, while the remaining stumps retard his advance.

As much time and trouble are requisite in the formation of such abbatis, I shall proceed to explain those which are not intended to supply the place of a parapet: and, in my opinion, they deserve the preference.

§ 413. (2). CARRY on your abbatis in a continued or broken line, as the circumstances may require; in the intervals, or in the front, throw up fleches or redouts which can support each other; enclose their gorges with palifades (fig. 3, *b*), or
with

with another abbatis, as at *c* ; and let them be joined to the main abbatis *d*, in such a manner as will enable the troops to retreat through them. These lines must be defended both by artillery and small arms.

§ 414. IN this case, your works ought to be as strong as possible, because the enemy must first get possession of them before he can gain the abbatis.—An entire abbatis may also be formed in the rear, that your troops may be able to make a second defence, in case they should be driven out of the works (fig. 3, *b*, *d*).—This method is advantageous when you wish to occupy a great extent of ground with few troops. For, if the works are properly placed, you can defend the whole abbatis from them, and of course it may remain unoccupied.

§ 415. IN General Peyfegar's Treatise on the Art of War, we find another method of forming an abbatis ; which, tho' troublesome, deserves to be recommended.

—“ If,” says he, “ there should happen to
“ be a wood near the place to which you
“ are carrying on your approaches, cut
“ down the large trees so that they may
“ fall on each other; twenty paces in their
“ rear, place a double row of palifades or
“ pickets wattled with twigs, three feet
“ asunder, and fill up the centre with
“ earth.—By these means you will have a
“ parapet of four or five feet in height;
“ from whence the abbatis, which acts as
“ a line, will be completely defended.”

§ 416. AN abbatis when made in the front of an out-post need not be very strong, because it is merely intended to secure the troops from a surprise, and to enable them to fight with advantage. — In this case it should be placed at the edge, and not within the wood as before recommended; that they may retreat in greater security, and harrafs the enemy from behind the trees. — Or, if several abbatis are formed behind each other, they will be able to retire from
one

one to the other, and to continue fighting till they have either driven off the enemy or received a reinforcement.

§ 417. IN the last Silesian war, the Prussian hussars frequently leaped over the enemy's abbatis to attack their advanced posts; and, although they generally lost their lives in the attempt, the sentinels were frequently cut down.—It once happened, near Freyberg, that they got within the abbatis by forcing their way through the forties. After that time, I always made them between two trunks of trees which were sawn off about five feet above the ground, and covered by a third or a beam.—This precaution gained me considerable esteem and confidence among the Croats.

§ 418. WHENEVER the Croats were posted in the open fields, or in villages with large debouchées, they covered themselves with stakes driven into the ground, as a security against the hussars.

§ 419. ALTHOUGH it may require labour and time to form an abbatis, when the trees are not to be had upon the spot, yet they are frequently of great use; particularly in ravines and hollow-ways.

§ 420. THE third object in the formation of an abbatis, viz. that of guarding a ravine, &c. will be explained in the 19th Chapter.

CHAPTER XVIII.

Of Inundations.

§ 421. **A**N inundation is formed by stopping the usual course of a stream: either for the purpose of securing the flank of an army, or of diminishing the number of posts, which would otherwise be necessary for the defence of a tract of country.

§ 422. As this is the most troublesome part of the duty of a Field Engineer, I
I shall

I shall endeavour to give a correct explanation of it in all its branches ; but particularly of that which includes the construction of dams and sluices.—First, on account of its difficulty and importance, and 2dly, because the generality of authors (especially in Germany) have either omitted it altogether, or only treated of it in a superficial manner.

That the subsequent matter may be clear and comprehensive to my readers, I shall first point out the rules which are to be attended to in forming an inundation ; and then consider its use and position.

O F D A M S.

§ 423. WHENEVER a short dam is covered by our own artillery, or out of the reach of the enemy's batteries, Pl. 20. fig. 2, *a* ; its strength must depend entirely upon the weight and velocity of the water, which it will have occasion to resist.—But if its length should deprive it of these advantages, as is the case at *m* and *n*,
or,

or, if it is to be apprehended that the enemy may either fire through it, or march over it to attack our position; works must be thrown up in the centre, as at *b b* and *c*, or at the end *d*, and well supplied with cannon.—The sluice *z* may be covered by an epaulement at *y*.

The weakest dam ought never to be less than four feet in breadth at the top.—The breadth of the bottom will of course depend upon its height.—See fig. 1.

§ 424. WHETHER a dam is to keep up a body of standing water or to resist a stream, the slope on the upper side ought to be at least equal to twice its height, as shown by *d e*, *f g*, in fig. 1, that it may destroy the effect which its constant motion would otherwise have upon it; especially when driven down by the wind.—On the other side it may have a natural talus; that is to say, equal to its height, (fig. 1, *b i*, *k l*).

The height of each dam is found in the following manner :

§ 425. WHEN water cannot be raised to the depth of five feet behind the dams, holes or ponds should be made between them, as at *e* in Pl. 20. fig. 2, to stop the enemy's passage.—Or a deep ditch may be cut, as at *f*, which will also give you a sufficient supply of earth.

§ 426. THAT five feet depth of water may be raised behind each dam, it is first necessary to estimate its fall between each of those places where they are to be built.—This may be done in different ways and with a variety of instruments*. But as they are all founded on mathematical principles, and explained in almost every book which has been written upon the subject of mathematics, it will not be necessary for me to trouble my readers with a tedious repetition of what the generality of them must have a competent knowledge. When millers or watermen are in the neighbourhood, the fall of the water

* See the words *Level* and *Levelling* in Capt. Smith's Military Dictionary, or the "*Traité du nivellement de M. M. Picard et Bullet.*"—Translator.

may be learned from them; but if no intelligence is to be had, the lower dams ought to be made higher than usual, that the inundated water may not obstruct the formation of those above *. Afterwards, they can be reduced to a proper height.

§ 427. IN cases of necessity, a small inundation may be formed without ascertaining the exact fall of the ground; but in large inundations the true level must be known.—For those therefore who may happen to want the proper instruments, or who are not sufficiently acquainted with this branch of mathematical knowledge, I have inserted a method by which the fall may be found with tolerable accuracy, though not without some trouble.

Take twenty or thirty staves, from one to six feet in length, as the nature of the ground may seem to require; mark inches

* This method will be productive of the inconvenience which the author supposes it will remove. His intention must be, that the *upper* dams ought to be made of sufficient height to keep up the water, while the workmen are employed in forming those below.—*Translator.*

and

and half-inches from their tops downwards, and let the upper part of them be perfectly flat, as shown in Pl. 19. fig. 4. Then provide yourself with a common level and plummet as used by carpenters, bricklayers, &c. that you may know when the staves have been driven to a sufficient depth.—A level is a straight piece of wood of about eight or ten feet in length, with a plummet suspended as at *k*, or let into another piece of wood placed perpendicular to its centre.

§ 428. WHEN you arrive upon the ground where the inundation is to be formed, place your staves *a*, *b* as far asunder as the length of the level may require; allowing *a* to remain only one inch above the ground.—Consequently, if *b* stands three inches above the ground, it is evident there must be a fall of two inches between *a* and *b*.—And in this manner you will proceed till you reach at the end of the line.

§ 429.

§ 429. WHEN the ground is uneven, a stake or picket must be placed wherever it rises or falls, as at *d, e, f, g*; and as the last is found to be a foot above its surface, the whole fall from *a* to *g* must be eleven inches.—In all cases this operation ought to begin where the ground is the most elevated, even if it should happen in the centre of the line. And when any of the pickets have been driven too far, you should fix small pieces of wood upon them which have been previously measured; that they may be brought to a proper level without being again pulled out of the ground.

§ 430. WHEN several dams are to be made, as in Pl. 20, fig. 1, A, B, C, D, and I wish the inundated water to be at least *five* feet in depth; A must be *six* feet high, otherwise it will wash over and destroy its summit.—If the ground should fall one foot down to B, that dam must be *seven* feet high, and the water about it *six* feet in depth.—And if the fall

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from

from B to C should be *one* foot more, that dam must be of proportionable height.—The size of the plate has obliged me to place the dams too near to each other.—A *b* shows the line of horizon; *b c* the whole fall from *a* to *c*; *a c* is the bottom of the water; *m n* its level when raised behind the dam; and *w d* its natural depth.—*O i*, *p f*, *q l*, and *r u*, represent the acquired depth throughout.

§ 431. THAT the fall of the water might be clearly expressed, I have described the dams A, B, C D, following the stream: but when they are constructed, the beginning should be made at D, and the order changed to D, C, B, A. For, if I began with A, the inundated water would entirely prevent my finishing those below*.—When a sufficient number of workmen are to be had, all the dams may be begun at the same time: provided openings are left in the middle,

* Here the author has repeated the error, which I have already taken notice of and corrected in my note upon the 426th paragraph.—*Translator*.

that

that the stream may flow without interruption till every other part is finished.

§ 432. (1.) A DAM may be formed merely with earth and rubbish ; (2.) it may be strengthened with a revetement of turf and quicks ; (3.) with twigs wattled upon stakes ; (4.) with fascines ; and (5.) with piles.

§ 433. (1.) THE first is the easiest and most expeditious method of making a durable dam : especially if the inundation is small and the stream not rapid.—But if you are under the necessity of forming such dams in a great inundation, the base or foundation of them must be very broad, and their slope on the upper side extremely gradual. They are constructed after the manner of parapets, and the earth may either be brought from the most convenient places near the water, or taken out of holes as at *e*, in Pl. 20, fig. 2 : which will render the passage of an enemy still more difficult.

§ 434.

§ 434. THAT part which is to resist the stream must be left open till the whole is finished, and channels cut for the purpose of carrying off some of the water.—When it is enclosed you must either use water fascines with a covering of heavy stones, or drive down strong piles on each side, equal to the height and breadth of the dam, and fill up the middle with stones and clay (Pl. 19, fig. 5, *a b*). In some cases, however, one row of piles may be sufficient, as shown by *c*.

§ 435. (2). A DAM with a revetement of turf and quicks is very durable, but much time is requisite before it can be in a state of perfection.—It is constructed in the following manner:

Two rows of large fods are laid one behind the other, on the side next the stream, with the grass downwards; that the revetement may be at the least two feet in depth: upon them there is a second layer of the same kind, with a row of quicks and green willow twigs; their tops barely

appearing beyond the fods.—Then follow two more layers of fods with quicks and willow as before ; and in this manner the work is continued till the dam has attained its proper height.—Afterwards the top is sloped off towards the stream, and well watered ; Pl. 19, fig. 6.

§ 436. (3). THE third species of dam is still more durable, and will resist the shoals of ice after a sudden thaw much better than the strongest piles : its construction is as follows.

Green willow staves of two or three inches in diameter must be driven into the ground, along the lines which mark the intended thickness of the dam, and as far asunder as may be necessary. Their tops must project about a foot above the ground, and when they have been wattled with twigs, and the cavity behind them carefully filled up, the earth must be rammed down. The second row of staves must be a foot behind the first, and one foot above it ; the third row a foot higher than the second ;

I

and

and thus the work will be continued till the dam is of sufficient height. Each step being covered at the same time by green willow twigs with their small ends outwards. (Pl. 19. fig. 7.)

The three lower rows of staves must have firm hold in the ground, but those above need only be driven into the earth, which has been thrown up for the formation of the dam.

§ 437. (4). THERE are two ways of forming the revetement of a dam with fascines; the first consists in placing them as in Field-works*; and the second, in laying them with a gradual slope to the top, as represented by fig. 8, Pl. 19.—In the first case, the water may loosen some of them (notwithstanding they have been bound and anchored with extreme care), and if one should give way the whole dam will be in all probability destroyed. But in the second, they will resist the greatest

* See my additional fig. d, Pl. 4.—*Translator*.

force, because their ends can yield to the motion of the water. The fascines which are used for these purposes ought always to be composed of green willow twigs.

§ 438. (5). By the 5th and last method a dam may be made capable of resisting a great and rapid body of water ; provided it is not injured by shoals of ice. But its construction will be expensive and tedious.

Piles of six or eight inches in diameter must be first driven into the ground with ramming machines, about a foot or eighteen inches asunder, according to the rapidity of the stream (Pl. 21, fig. 1, *a a*). Between, and in front of these piles a wall ought to be made of large square stones, and cemented with moss.—In some cases the middle of the dam may be formed merely with earth. And, if that should be insufficient, it may be strengthened with smaller piles (*d d*), or with willow staves, driven from two to four feet asunder, as at *e e e*, and allowed to project a few

few inches above the earth when the work is finished.—If necessary, there may also be layers of green willow twigs between every two or three feet of earth, as at *ff*: which, in the course of a few years, will give the dam uncommon strength, and enable it to keep up the water after the piles and wall have been destroyed.

Whenever such a dam is to be formed where the river bends or washes violently against one particular part, its force may be broke by square beams of wood, laid and fixed upon each other till they are even with the top of the work; as shown by *c b*.

R E M A R K.

§ 439. IF the scarcity of stones, or the expence of such a wall, should make it advisable to adopt some other method; fascines may be used, as directed in the latter part of the 437th paragraph: and I believe the dam would in that case be still more durable.

This fifth method will be equally useful in banking up or repairing the sides of a river.

§ 440. WHENEVER a dam has no sluice or channel, for the purpose of carrying off the superfluous water, the end round which it flows must be extremely well defended.— In such cases, the first and second species of dam will be too weak, and the third the most preferable; provided its head is made circular, as in Pl. 20, fig. 2, *g w*, and Pl. 21, fig. 3.

OF SLUICES.

§ 441. As it may be easily supposed I do not mean to describe the walled sluices or batardeaus that are usually formed in the works of a fortrefs, I shall confine myself to two kinds; which will be fully sufficient to answer every purpose that can be required of them in such inundations as are now under our consideration.

§ 442.

§ 442. To form those of the first kind, you must either drive piles of alder or oak close to each other, as shown by *a a*, Pl. 21, fig. 2 and 3; or about four feet asunder, and line them with boards, as at *c d*: but this method is not so durable as the former. In both cases they must be continued at the least five or six feet into the dam on each side, and their tops let into a strong beam. — *i i*, in fig. 2, represent this beam; *b b*, the extent of the wood-work within the dam; and fig. 3, the appearance of the piles before the beam is laid upon them.—The openings which are left for the water must be two, three, or four feet in breadth, as its width or rapidity may seem to require; and the piles on each side must be very strong, and made with a groove down their centre to receive the door *g*: which may be easily raised and let down by means of the handle or lever *b*.—The corners of the dam *k, l*, must be also circular.

Such sluices ought to be well defended against the enemy's artillery, as in Pl. 20, fig. 2, 3; and, when that object is not to be

attained, I would give the preference to such as are described in the next paragraph : because they can never be injured by cannon-shot.

§ 443. SECONDLY, you may make a common millers dam, with a foundation or base equal to five times the intended depth of the water, as shown by fig. 4 and 5, which will answer all the purposes of a sluice.—Let the piles *A* be supported by strong pieces of wood, as at *b b*, fill up the spaces between with rubbish or stones, and give them a covering of thick planks or rafters, that the water may not force its way under them. The breadth of this bed may be from six to twelve feet, according to the rapidity of the stream ; but the upper part of it must expand to receive the water ; and its sides ought to be secured with strong planks and piles. At the other end, the fall of the water will be broke by the boards *e f*, and carried away at the same time from the foundation of the work.

Whenever

Whenever the position of such a dam obliges the enemy's artillery to fire at it from above ; that is to say, from *d* to *f*, their shot cannot do it the smallest injury.

§ 444. AN inundation may be of two kinds ; and both formed to answer different purposes.

1st. A river or brook may be swelled merely with a view of destroying its fords, and of rendering a ravine impassable * : and 2dly ; a tract of country may be laid under water to secure the flank of an army, or one side of a fortress, from the attacks of an enemy †.

The first is in every respect advisable, and can be made with the utmost ease : but the second is of so serious a nature, that every circumstance attending it, ought to be previously and thoroughly considered.—In the first place, such an inundation is at all times highly injurious to the country wherever it extends ; secondly,

* See Vol. V. Sect. 1 ; and Pl. 1, N° 10.—*Author.*

† See Vol. IV. Sect. 4, and Pl. 5, N° 23.—*Author.*

it requires more time and labour in its formation than may be at first imagined; thirdly, it is difficult to secure its dams from the enemy's artillery; fourthly, it will probably be useless in a severe frost; and fifthly, it will tend to create dangerous disorders in every other season of the year.

§ 445. By the first of these inundations, a position may be considerably strengthened: and the smallest brook will be sufficient to overflow the ravine in which it lies, so as to put a stop to the advance of an enemy against that quarter.—If the ravine is not too broad, a dam may be made entirely of earth (§ 433), so as to extend from one side to the other, (Pl. 20, fig. 2 *a*); and if the ends *g*, *b*, are well secured, the water, when raised above five feet, will flow round them without injuring the work.

§ 446. If however the sides of the ravine are so steep that the water cannot be carried off in the manner above mentioned, and if
there

there are sufficient reasons for not making a sluice in the centre ; both its ends must be made lower than the other part, that it may flow over them.—In that case, they must be composed entirely of water-fascines, rubbish, and stones, with piles on each side ; and carefully sloped off or boarded at the top.

According to the fall of the water, these dams may be from an *hundred* to a *thousand* feet asunder.

R E M A R K.

§ 447. ALL dams ought to be formed obliquely cross the stream or river, that the water may not have much power upon them ; Pl. 20, fig. 2, *a*, *k*, and *m*.

§ 448. WHEN the ground is low on both sides of a river or brook where an inundation is to be formed, the dams must be of a proportionable length, as at *m*, *x* ; and, unless there should be a considerable depth of water, with a gentle fall, it will scarce be possible

possible to raise it to a sufficient height: especially if the flat is of great extent.—In that case you must add ponds or holes, according to the 425th paragraph.

§ 449. WHENEVER the enemy can get near enough to destroy those dams, which, on account of their extreme length, are not to be defended by artillery; or whenever he can march over them to attack our position, different modes of defence will be requisite. In the last instance, they may be secured by felled trees, with their branches outwards, or by chevaux-de-frise. But in the first case, the whole should be formed *en zig-zag*, with a continued parapet from one end to the other; or, if that cannot be done, they must either be covered by small works, as at *d* in fig. 2, or by parapets or other works upon their centre; as shown by *b b* and *c*.

§ 450. A LARGE inundation will secure any part of a position or fortrefs from the enemy's attacks; it will enable you to withdraw

draw many of your troops, which would otherwise have been necessary for the defence of that side, and to employ them elsewhere; and, in the third place, it will give you an opportunity of bringing water into the ditches. — But, as a great extent of ground must be laid under water, it will be necessary that the following points should be ascertained with accuracy.

§ 451. (1). THE level of the country must be found, as well as the weight and fall of the water: partly, for the purpose of knowing if the inundation will cover the whole of the intended ground, and partly, that we may be certain of not making it disadvantageous to ourselves. For if it was to be raised too high, or liable to be suddenly swelled with rain, our own position or encampment might be flooded: particularly if the channels were not large enough to carry off the water in proportion to its rise.

§ 452. AT all events, to prevent an overflow of our own position, a dam may be
thrown

thrown up, as at *o p*, Pl. 20. fig. 2, and if it is formed with salient and reentrant angles, it will be equally useful as a parapet.—Of course it must be of sufficient strength to oppose a body of water, and to keep off the fire of the enemy's artillery.

§ 453. WHENEVER an inundation is thus bounded by a dam or parapet in front of our position, the cross dams ought to be well defended by their own works.—And, although those works may support each other, it is equally necessary that they should be covered by the fire from our lines, as shown in the 20th Plan.

§ 454. IF our position or encampment is so high that the inundation cannot be productive of inconvenience to us, and if its depth puts it entirely out of the enemy's power to make an attack upon that quarter; the parapet *o p* will be altogether unnecessary.—Nevertheless, fleches and batteries will be requisite for the defence of the dams, (fig. 2, *q, r, s*): especially if an
attack

attack should be made upon them during the night.—And, however formidable their defence may be, the tops of trees and palifades should be added, as at *x* : or, if chevaux-de-frise were fixed to the ground with long hooked pickets, they would perhaps hinder his approach more than the trees, and afford him no shelter from our grape and musket-shot.

§ 455. THE works at *c* and *d* must be defended by fifty, eighty, or an hundred men ; who can never be permitted to retreat, unless that side of our position is raised and covered by batteries, as at *p*, *s*, *w*, to prevent the enemy from forcing his way within the lines at the same time. And, as every thing must depend upon the preservation of the dams, even this will be frequently refused ; and the officers, to whom such commands are given, will receive orders to defend themselves to the last extremity.—For the loss of an hundred men cannot be an object of consideration,

ration, when the safety of an army is at stake.

§ 456. As I have now pointed out the methods of keeping the enemy at a distance from our dams, and of forming a sluice which cannot be injured by cannon-shot, it will not be necessary for me to say more upon this subject; except that a strong epaulement, as at *z*, may be sometimes extremely serviceable.

§ 457. THE inundation which was formed by the Austrians, near Dresden, in the year 1760, was so well placed and defended, that, if it had been completed in time, the Prussians could not have succeeded in the destruction of the town.

C H A P T E R XIX.

*Of the Methods of retrenching Heights and
high Positions.*

§ 458. **I** HAVE already had occasion to say so much upon this subject, that an attentive reader will be apt to consider the present Chapter in great measure unnecessary.—But as it is of the utmost consequence to an Engineer, to have a perfect knowledge of this branch of the military science, I am induced to bring together its several parts, and to give them a more ample consideration.

Hills are either high or not high, steep or not steep.—Each require different works for their defence, and in all cases the Engineers must know whether they can or cannot be commanded.

§ 459. HIGH and steep hills or rocks require the fewest works, and whenever there are only two or three roads which

lead up to them, they can either be destroyed by abbatis, or by broad and deep ditches.—In the latter case, the earth may either be carried away after it has been dug out, or used for the purpose of raising the side which joins our position, as in Pl. 22. fig. 3, *k*.—But if they should be wanted for our own convenience, they may be defended by barriers, chevaux-de-frise, palisades, or traverses : provided a free passage is left between them (Pl. 23. fig. 1).—Or, when the fall of the ground is not too steep, they can be sufficiently raked by a few field pieces, as shown in Pl. 22. fig. 3, *l*, and Pl. 30. fig. 5, *g* ; and defended at the same time by the fire of small arms from *m*, Pl. 22.

§ 460. THE sides of such heights ought also to be well attended to, notwithstanding their apparent difficulty of access ; on account of the probability that a determined and active enemy may ascend the most unsuspected parts : especially when they are covered with wood.

†

§ 461.

§ 461. WHENEVER a height is overgrown with trees, two strong abbatis ought to be formed within them ; the one at the bottom of the ascent, as shown by *n n*, Pl. 22. fig. 3, the other at the edge of its summit *o* ; and both occupied by troops.— But if it is only lined with brush-wood, the whole must be cut down, as at *n*, that the enemy may not be sheltered from our fire.

§ 462. THE *Sturmbalken*, which have been described in the 391st paragraph, may also be used wherever the sides of a height are smooth.—Two, three, or more rows of them must be laid behind each other, close to the summit, and merely supported by wedges ; that they may be at once rolled down upon the enemy as soon as he has made good half his ascent.—If the first should not answer the purpose effectually, it must be immediately followed by the remaining rows : and, if the park of artillery can furnish any old *sacs-a-poudre* or

loaded shells, they may be thrown at the same time with lighted fuzes.

Whenever a hill can be fired upon by artillery from other heights, the works which are formed upon it ought to have the usual profile against cannon-shot; and, if either of the flanks are commanded, they should be covered by epaulements.

§ 463. WHEN a hill is not commanded by artillery from other heights, works of palifades should be made upon it, according to the form of its summit, instead of earthen parapets. Because they will keep off an enemy more effectually in case of a storm, and the shot which are fired at them from below will do little or no injury (§ 253).—If the palifades are placed in two rows, for the sake of greater security, the first should stand in an oblique direction pointing outwards, and the second perpendicularly, close behind the first.

§ 464. IN these cases, it is generally advantageous to form the ditch behind the
parapet,

parapet, as in the profile u, Pl. 8: because you can then lay your works near enough to the edge of the height, to gain an entire command over its declivity, and to roll the *Sturmbalken* from the parapet; which will be more destructive to the enemy than the fire of small-arms.—The same method of forming the ditch will be equally useful if you wish to defend a ford or bridge below the parapet.—See Pl. 20. fig. 2, l; Pl. 22. fig. 3, c, d, e, f; and Pl. 30. fig. 5, c.

§ 465. IN the formation of works upon heights, you are to endeavour to gain a complete command over their sides and approaches.—This is your only object, and you are not to regard any rules which do not lead to the attainment of it.—See Pl. 22. fig. 3, and Pl. 30. fig. 5.

§ 466. HILLS and heights of gradual ascent are always favourable for defence; because they give your fire its full effect; Pl. 30. fig. 4.—But, as their approaches are not difficult, a determined enemy will

march up without hesitation, unless the works upon them are well constructed, and every obstacle thrown in the way which either art or nature can point out : particularly such as will oblige him to advance in column against your batteries.

§ 467. ALTHOUGH there may not be any trees upon the spot, the advantages which are to be derived from an abbatis, in such a situation, will amply repay the labour and trouble of bringing them from the nearest woods.—They should be placed within the fire of artillery, but beyond the reach of grape-shot; for if they are not more than three hundred paces from your works, they will give the enemy too much shelter.—Consequently pickets, trous-de-loup, and ditches, ought rather to be made use of within that distance of a parapet.

§ 468. PICKETS are of more use against cavalry than infantry : but trous-de-loup are equally serviceable against both, provided the rules which have been pointed out

out in the 386th paragraph, are sufficiently attended to.—Pl. 22. fig. 3, 7, and Pl. 28.

§ 469. AN *avant-fossé* running parallel to our lines, at the distance of about an hundred paces, will be of great use, if the earth is either carried away when dug out of it, or formed into a glacis on the opposite side*.—It is also to be remembered, that every part near the works must be sloped off, as in Pl. 22. fig. 1 and 2, that the whole may be completely raked by the fire from the batteries : otherwise the enemy may make a secure lodgment in it.—The intent of such a ditch is to retard the advance of an enemy and his artillery, consequently much depth is not required ; and in general the space between it and the main ditch is filled with *trous-de-loup* (fig. 2.)

§ 470. WHEN heights rise with breaks

* See AVANT-FOSSE, Vol. V. Sect. 3.—*Author.*

above each other (as is generally the case near rivers), small works should be formed for the defence of all the bridges or fords below.—For instance, those at *c d*, in Pl. 22. fig. 3, defend the bridge at *a* and the ford *b*; and *c*, in Pl. 30. Prof. 5, covers the bridge *D*.—And, that they may be effectually under the command of the works above them, their gorges should either be left open, or only enclosed with palisades, as at *c, d*, and *f*, according to the nature of the ground.—But this will be more clearly understood by examining fig. 3, in Pl. 22; fig. 5, in Pl. 30; and *l, r, s, p*, in Pl. 20. fig. 2.

§ 471. IN the formation of works upon the side of a hill, the salient angles will frequently lie low enough to give the enemy an opportunity of seeing over them, and of firing within the parapet: a disadvantage which ought at any rate to be obviated.—Therefore, whenever the ground will not allow you to place them in a more favourable position, those parts of the work
ought

ought to be raised as much as may be necessary, and three or four banquettes added within them. — Such an elevation is termed a *surtout* *.

§ 472. WHETHER the equality of our strength with that of the enemy, or even a decided superiority on our side, should induce us to wish for an attack; we must neither neglect to make the most of our position, nor to leave such apparent openings as will tempt him to march against those parts, where in reality we are the best prepared for his reception. — For instance; instead of throwing up works where the sides of a height have a gradual ascent, we ought only to place artillery in readiness, and to cover them either by sunk or masked batteries. — At the same time, we must endeavour to make every other approach as difficult of access as possible.

§ 473. THE more gradual the descent

* See M. le Blond's *Elements of Fortification*, p. 102.

Translator.

from

from a hill may be, the more necessary it is that our parapets should be formed to resist cannon-shot.—And, if the works are enclosed, their rear sides may either be formed upon a very weak profile, as in Pl. 6 and 7, or merely with palifades.

§ 474. OUR works ought always to be large, when formed upon heights where cannon-shot can do little or no injury ; and they should be supplied with such moveable traverses as have been described in the 350th paragraph : because we shall then have the most to apprehend from the enemy's shells*.

* More may be found concerning the attack and defence of Heights in the first Vol. of my "ACCOUNT of the WAR, &c." Sect. 3 ; and in the sixth Vol. Chap. XIX.—*Author.*

CHAPTER XX.

*To defend Ravines, Valleys, Debouchés, and
Defiles, by means of Retrenchments.*

§ 475. **W**HEN such places lead towards our encampment or position, they ought to be occupied by infantry (and particularly by light troops and free corps); as well as the heights above them.—If that is properly done, a few works will give the enemy incredible opposition, and we can neither be out-winged nor taken in flank.—But if an inexperienced officer should suppose, that the troops below will be alone able to keep off an enemy; he will be convinced of his error by the loss of those men, and probably by a general attack upon the army.

§ 476. AN inundation will also obstruct the advance of an enemy through ravines, valleys, or defiles; or an abbatis may be
made

made use of for the same purpose, provided it extends so far up the hills on each side, that his light troops cannot march round it.—Pl. 22. fig. 3, *n, o*.

§ 477. As such places are seldom without wood or rivulets, either of those means are within our reach. Consequently, we are at full liberty to adopt whichever will cost the least labour, or be the most likely to answer the purposes required of them.

§ 478. BUT, before such means of defence are adopted, it is to be considered, whether a passage through those places can be hereafter useful to our own corps, or not.—In the latter case, exclusive of a common inundation or abbatis, every kind of obstacle may be thrown in the way; and if there should not be a sufficient flow of water, deep ditches may be cut cross the bottom of the ravine, &c. Hollow-ways may be filled up with the trunks of trees or large stones; and if holes are made in them, the earth should be thrown upon the
the

the banks on each side: that the enemy may not be aware of the difficulties he will meet with, till he arrives at the places in which they are formed.—Pl. 22, *k*.

§ 479. IN the first instance, an inundation is not to be recommended, even although a road might be raised at the same time, with a view of enabling you to march through it in security: for, in such a situation, it would probably be laid under water, or rendered useless, after the first heavy rain. I should therefore prefer palisades, abbatis, breastworks, or traverses, whenever I am thus circumstanced: and, if they were to be placed as in Pl. 23. fig. 1, 13, 15, and 16, the enemy's artillery could not rake the length of the ravine or valley; while mine would have its full effect.

§ 480. IF one end of a ravine reaches our encampment or passes through it, while the other forms a debouché near the enemy; the heights on each side and the debouché itself should be defended by enclosed

closed works: and those works ought to be strengthened with palisades, fraises, and chevaux-de-frise. — The ravine of Tannhausen, near Upper-Gierdorff, was secured in this manner, when the Austrian camp was formed upon the 22d of July 1762. — And, when there are woods at hand, an abbatis may be used for the purpose of joining all the detached works to the main retrenchment of the army. — This was also done by the Austrians, when they were encamped near Tannhausen upon the 7th of July 1762; and it enabled them to defend the ravine of Burkersdorff, through which the river of Schweidnitz passes *.

* See Vol. VI. Chap. XXII. — *Author.*

C H A P T E R XXI.

Of the Defence of Rivers.

§ 481. **W**HEN works are formed for the purpose of covering our position, and of stopping the enemy's passage of a river; particular attention must be paid to the situation of the bridges, their state, and the materials with which they are built. And we must at the same time examine all the fords and shallow places with the utmost care.—Such bridges as are likely to be of use to our own corps may be suffered to remain, especially if they are built of stone: and in that case a small work should be formed above each, with one or two pieces of cannon, that we may be able to rake them effectually, and to destroy them whenever it may be necessary. Pl. 22, fig. 3, *b, c*; and Pl. 30, prof. 5, *c*.—But those which cannot be serviceable to us, ought to be at once removed.

Whenever we meet with wooden bridges,

ges, an examination should be made into the possibility of their being battered down by the enemy's artillery; either from the neighbouring heights, or in case of an attack.—And if there is the least danger of such an event, none of our troops should be sent over the river, lest they should be entirely cut off.

§ 482. A MINE may also be laid under the centre of a bridge, for the purpose of destroying it whenever it may be advantageous to do so: as was the case when the Austrians intended to storm Dresden in the year 1759.—Its success, however, would be attended with some uncertainty: first, because the enemy might kill the men who were ordered to spring it; and secondly, because the effect of its explosion might be greatly diminished by the water.

§ 483. WHETHER an intire line is thrown up along the side of a river, as in Pl. 20, fig. 2, *o*, *p*, or detached works, as in Pl. 22; it ought always to be considered as a general rule,

rule, that the defenders must be able to see the river, and to command it wherever it is possible with a horizontal fire.—Pl. 30, fig. 5.

§ 484. ALL parapets and batteries, which cover the passage of a river, ought either to be sunk or placed as low as possible: especially if they are too much commanded from heights in the enemy's possession. Pl. 22, fig. 3, *c, d, e, f*, and Pl. 30. fig. 5, *c*.—And there must be a safe communication between them and the main retrenchment upon the summit of the heights; as at *g, h, i*. But if we suppose it impossible for the troops, by whom they are occupied, to make good their retreat (as is sometimes the case); they must consider it their duty to fight to the last extremity. For if an obstinate resistance is made, the loss of a few men, with one or two field-pieces, will be amply compensated by the injury they will have done to the enemy.

Men and money ought never to be too much regarded in military operations,

when any thing is to be gained, or when matters of importance are to be executed.

§ 485. IF the front of our position is not too long, these means will stop the passage of an enemy, notwithstanding he may be greatly superior to us in point of numbers: except when there happens to be a large extent of flat ground. — In that case he can cross the river some miles above or below our works, without the possibility of our being able to oppose him. And indeed, if there should be a faint prospect of successful opposition on our side, it is necessary for us to remember there is extreme danger in extending our posts too much, and that, by endeavouring to cover more than we ought, we may allow him to break through our chain, to carry off our posts, and either to throw our whole corps into confusion, or oblige us to make a disgraceful retreat.

In general, more will depend upon the strength of the armies which are acting against each other, and the nature of the country,

country, than upon any established rules.—Therefore I can only add those which may be useful on most occasions; subject at the same time to such alterations as circumstances may seem to dictate or recommend.

§ 486. THE bridges which are suffered to remain, must be covered by works (as I have already observed in the 481st paragraph), and such batteries should be placed above them as will make it impossible for the enemy to attempt a passage.—All fords ought at the same time to be destroyed. This may be effected by laying trees in them with their branches outwards; by sinking harrows with their teeth uppermost, and fixing them to the ground; by throwing in large stones; by digging holes in them; or by increasing the depth of the water, according to the 444th paragraph.—It is immaterial which of these methods are adopted; provided those parts of the river are so well covered by parapets or fleches, that the enemy cannot repair

them or remove the obstacles that have been laid in his way.

§ 487. PARTICULAR attention must be paid to all shallow places ; and whenever the river forms a curve towards the enemy, we ought to throw up works in the gorge or opening on our side ; that his progress may be effectually stopped (even after he has passed the water), till the main army can have time to assemble.—And, as he will not have room to extend his front, our cannon and grape-shot will be doing considerable execution in the mean time.

The Chevaliers de Folard and Clairac have entered largely into this subject : but, as no particular kind of work is required, it will only be necessary for me to observe, that the lines which are thrown up on such occasions may either be enclosed or composed of separate fleches ; and that they should always have a concave form, for the purpose of giving a more concentrated fire upon one point.

§ 488.

§ 488. If the part of the river we wish to defend, is not above eighteen or twenty miles in length, the best mode of proceeding is to take away all the boats we can find, to throw up works at every ford or fordable place, and to let them be well occupied.—Then to divide the army into four different corps, to post three of them along the river, about five miles asunder; while the other remains in the rear, as a reserve. By these means, such an extent of country may be secured, but more cannot be properly covered.

R E M A R K.

§ 489. It may be remarked at the same time, that an enemy cannot march above twenty miles without our knowledge, if we are sufficiently upon our guard. Therefore, whenever he may have made an unexpected movement up or down the river, we ought to follow him: provided we have previously reconnoitered the country according to the 49th paragraph, and had

the precaution to destroy the bridges, fords, &c. that we may be able to take up a new position.

§ 490. As it is of the greatest importance that these corps should have an easy communication with each other; the roads between them ought to be well repaired; and every obstacle must be removed which can tend to delay the march of the troops.

§ 491. ABOUT six or eight miles in the rear of these three corps, a convenient place of rendezvous ought to be pitched upon and properly retrenched: in case there should be occasion to make use of it as a field of battle.—Upon this ground the fourth corps or reserve will guard the baggage, the park of artillery, and whatever might impede the movement of the rest of the army.

§ 492. ROADS of communication must be made from every corps and work to the
place

place of rendezvous; and all the bridges and defilés properly occupied. Beacons, signal-guns, and sentinels must be placed along the bank of the river; while pickets patrol continually between the three corps every quarter of an hour. And a few men should be sent occasionally in boats under the opposite shore (particularly during the night) to watch the enemy's motions.

§ 493. IN case of an alarm, each corps will assemble at its appointed place; but, as the enemy may probably make a feint at one point, with a view of misleading the troops while he is effecting a passage in some other part, the strictest orders should be given that no corps shall stir from its position without directions from the General who commands the army.—However, it may not be improper, that a reinforcement of a few thousand men should be sent, at the first signal, from the reserve to that corps on which an attack is threatened.

§ 494. As soon as it is evident that the enemy intends to pass the river at one, or at two places, the nearest troops will be assembled, and every effort made to oppose him, and destroy his bridges.—If this is found impracticable, the different corps will retreat, in obedience to their orders, to the general place of rendezvous: where they will be formed in order of battle, and prepared to receive his attack.—By such exertions, a disgraceful flight, or a confused retreat, will be avoided*.

C H A P T E R XXII.

Of the Defence of Church - yards, Walled - yards, and Farm - houses.

§ 495. **A**S M. de Clairac has treated this subject in a very complete and circumstantial manner, I shall refer my readers principally to his work; and

* More may be found upon this subject, and upon the different methods of defending a coast, in the sixth Vol. and twenty-second Chapter of my "ACCOUNT of the WAR," &c.—*Author.*

confine

confine myself merely to those general rules which will at all times demand our attention.

At present, troops will seldom have occasion to defend themselves in houses, castles, &c. for any length of time, on account of the increased use of artillery; against which, a well-placed work is in every respect preferable. Sometimes, indeed, the peculiarity or strength of their situations may enable you to convert them into good posts; but even then, time and labour must be expended before they can be put into a state of defence, and, after all your endeavours to the contrary, the enemy can set them on fire almost whenever he pleases, and the stones which are broken off in the course of a cannonade, will be as dangerous to the troops within, as the shot themselves.

§ 496. WHENEVER sufficient time and workmen can be spared, it is better to throw up a new work, than to employ them in strengthening houses or walls.

First,

First, because you will have less to fear from the enemy's artillery, while your troops are at liberty to support each other; secondly, because you can make the best use of the ground by giving it a judicious position; and lastly, because you can make your profile of any dimensions, and regulate its size according to the number of men intended for its defence.

§ 497. THE common occasions wherein it is either necessary or advantageous to fortify a house, and to make use of it as a post, are:

1st. When a detachment has either been cut off by the enemy, or suddenly attacked on the march.

2dly. For the defence of a defilé, or to cover a magazine.

3dly. When the severity of the weather obliges you to put your men under cover. And,

4thly. When its favourable situation renders it a place of considerable strength.

§ 498.

§ 498. THAT the particular use and defence of every kind of building may be clearly understood, I shall give each a distinct consideration.

OF THE METHODS OF STRENGTHENING
AND DEFENDING A GARDEN - WALL,
OR A WALLED CHURCH - YARD.

It frequently happens that such walls may be of service to a picket; and that they may enable a body of men to defend themselves till assistance is sent to them, or till a favourable capitulation can be made with the enemy : that is to say, if they are of sufficient strength without any addition ; or if time can be spared, and the necessary materials found, by which they may be made so.—Brick walls are the best for such purposes, because they cannot be so easily knocked down as those which are made of quarry or free - stone, and their defenders will not have so much reason to be apprehensive of splinters.—Here the troops are usually posted two deep as behind a parapet,

pet, with a reserve in the rear to lend assistance wherever it may be wanted. But if the wall is too long to admit of such a distribution, they must be posted in a rank entire; that the whole may be equally occupied. A sufficient quantity of wood may be taken out of the nearest houses; and whatever is most essential towards repairing the wall, ought to be done with the utmost expedition, on account of the danger of an immediate attack.—And if that should not take place, the other parts of the work may be afterwards continued till the whole is in a complete state of defence.

§ 499. It is first necessary that all the doors and openings should be as well barricaded as time and circumstances will allow.—Therefore, if an immediate attack is expected, and the doors open inwards, strong wooden props should be placed against them: or, if they open outwards, they should be nailed up; and stems of trees or spars may be driven into the ground close to each other, to be used as palisades.

Waggons

Waggons will also answer the same purpose, and if some of their wheels are taken away, the enemy will find a difficulty in removing them. Hewn trees ought to be laid in the openings with their tops outwards, and their trunks either covered with earth or fastened down with stakes.—In all these cases, banks of earth or horse-dung must be added with great expedition, and every space carefully filled up.—If the enemy should not arrive till this is done, their petards and cannon-shot will not do much injury.

On these occasions, a sufficient quantity of earth may be easily procured by forming ditches round the outside of the doors or openings ; as in Pl. 23, fig 14.

§ 500. WHENEVER it is necessary that the doors or openings should be occasionally used as forties, they may either be defended by strong tambours, as in fig. 2, 3, 4, and 5; or with small fleches and traverses, as in fig. 11 and 12. — To these I give the preference on account of their superior
defence

defence against artillery.—In some cases it may be advisable to lay them behind the wall, as in fig. 13.

If the time will not admit of such modes of defence, a ditch may be dug in a straight line cross each opening, and a parapet formed with the earth.—Both ends of these parapets must be joined to the wall.

§ 501. As soon as the forties are finished, the walls may be put into a state of defence by the following methods.—If they are too weak to resist cannon-shot, ditches should be cut on the outside, pointed at the bottom, and as far distant from them as the natural fall of their banks of earth may require. They ought also to be lowered to seven and a half or six feet, to avoid the trouble of making several banquettes, or of throwing up an unnecessary quantity of earth against them: and, as they will not stand in need of interior revetements, the work may be expeditiously completed.

§ 502. WHEN a wall is strong enough to resist in great measure the fire of regimental field-pieces, the earth need only be raised up to half its height. — You may then form a line of creneaux, as at *a*, in fig. 7; and, by raising a scaffold to *b*, another line of fire will be gained from the summit.

§ 503. IF there is great reason to be apprehensive of an attack before a ditch can be completed, the workmen must first knock down as much of the top of the wall as may be necessary, and the rubbish can either be used for the purpose of forming a banquette and platforms for the cannon, or thrown on the outside, as in fig. 9, *a*. — When this is done, a ditch must be made about four feet from the banquette or wall; and, if the earth is carefully thrown over, it will form itself into as good a bank, as if the ditch had been made on the outside. The steps, *b*, *c*, are left for the convenience of the workmen. — If baskets are to be had, one row of men must receive

ceive them when filled, and throw the earth over the wall: but if there are none, it must be thrown first upon the banquette.

§ 504. THERE are two ways of using cannon upon such occasions. 1st. Embrasures may be made as in a common parapet; and, that the enemy may not get through them when our ammunition is shot away, the width and depth of the ditch ought to be considerably increased in front of those openings. Or, if a ditch is only cut behind the wall, as in fig. 9, they will still require the same external defence.—If an attack should be made before the work is completed on the outside, the workmen can make their escape through the embrasures.

2dly. Platforms may be raised, with earth or rubbish, so as to enable you to fire *a barbette*; which is at all times practicable, provided the wall is not very high.—This method is, in my idea, preferable to the other; because the stones are not so likely

likely to be shook or loosened by repeated firing, and it gives you the command of a greater extent of ground;

§ 505. WHEN a bank of earth is not thrown up against the wall, two rows of creneaux may be cut through it, as in fig. 6 and 7.—Or, in some cases, it may be better to make only one, and to add scaffolding, so as to gain a second line of fire over the top.—If the wall is not strong, the creneaux may be six feet asunder; and the upper row of them must be made above the spaces which have been left between those below.—They are usually two feet and a half high within, and lowered one foot more on the outside, that the firelocks may be depressed to reach the foundation. Their breadth may be either six inches on the outside and eighteen within, or six inches within and eighteen on the outside, as circumstances may seem to recommend.—In general, however, the defenders will be obliged to content themselves with such as can be made with the

greatest expedition, without regarding any accuracy in their dimensions. In either of these cases, the lower row should be *seven* feet above the ground on the outside: otherwise they may be equally serviceable to the enemy.

It is sometimes necessary (particularly in buildings) that a row of creneaux should be made a few inches above the ground. In that case there should be a ditch within, to enable the soldiers to stand upright when they fire, as in fig. 8.

§ 506. WHEN much expedition is required, the upper row of men may stand upon boards, supported by bricklayers trestles. But if you have sufficient time and workmen, scaffolds ought to be made in the following manner:

You must first set up strong poles or spars ten or twelve feet from the wall, allowing their tops to project as far as the upper row of creneaux; and let other spars be nailed upon them for the security of the troops in firing. — Small holes must then

then be made in the wall, four feet and an half below those creneaux, to receive one end of the cross-spars, while the others are fastened with ropes or iron-cramps.—Upon these the planks may be laid lengthwise or crosswise, according to their strength: and, if necessary, the whole must be strengthened by props, as shown in fig. 6.—If a sufficient number of ladders are not to be had, strong planks will answer the same purpose, when placed as at *bc*, in fig. 7.

OF THE DEFENCE OF A SINGLE HOUSE OR
CHURCH.

§ 507. WHENEVER a church-yard is surrounded by a good wall, and the body of troops sufficiently numerous, I would recommend that they should defend themselves from thence as long as possible; and consider the church merely as a place of refuge, or as a magazine for the provisions and ammunition which they must necessarily have with them, in case it is

intended that the post shall be maintained. — Upon the arrival of troops at such a place, the doors and windows of the church should be prepared for defence, and barricaded; but not according to the idea of a certain author and his imitators, who are of opinion that a hole of three feet square should be cut in each door, for the defenders to creep through whenever they may be obliged to make their retreat: for, as it would only be possible for one man at a time to crawl through such an opening, it is evident, that that plan would be productive of the greatest danger and inconvenience.

§ 508. If a strong tambour is made in front of one of the doors of the church: and constructed so as to defend that side of the building, and to be covered at the same time from the steeple or windows; it will be properly secured, and an expeditious retreat may be effected: especially if its entrance is formed *en zig-zag*, and capable of admitting three men abreast.

Because,

Because, as soon as the troops find it necessary to withdraw themselves from the wall, a few men can file off to occupy that work and the most material parts of the church; upon a given signal, others can follow under the cover of their fire; and when the whole are in security, the entrance may be closed either by chevaux-de-frise or a barrier.

If the tambour should be found too weak to resist the efforts of the enemy, its defenders must retire into the church, barricade the door, and fire through the holes which have been previously cut in it for that purpose*.

§ 509. IF there is not a sufficient body of men for the defence of the wall, or if it is found to be in a very bad state, the church must be immediately occupied, and the doors barricaded in the best manner.—Such windows as are too near the ground

* In this, and the two preceding paragraphs, I have omitted some few lines, which were evidently unnecessary in an English translation.—*Translator.*

ought also to be boarded up, and cre-neaux made wherever they may be required: especially when a cross fire can be gained.

§ 510. THE same means are to be used in the defence of a house.—But the troops can then retire from room to room.—When the enemy is in possession of those below, they can retreat up stairs, and by pulling up some of the boards, fire down upon them.

However, in all these cases, it is to be remembered, that if the enemy is provided with artillery, he can soon batter down your building; if he has none, that matters are not likely to be brought to such a crisis; and if he should be so far successful, that there is a great probability of his setting the whole building on fire.

§ 511. To guard against fire, you should fill every cask you can find with water, carry away and burn all the thatch or shingles, cover the floors with wet dung, and
let

let a certain number of men be always in readiness to extinguish the flames. If it is possible, you should make use of the inhabitants for this purpose, and place sentinels over them; otherwise they will make their escape as soon as the firing is begun.—These precautions were found to be of great use during the siege of Colberg *.

§ 512. WHEN a house happens to have a balcony or gallery in its front, it should be lined with sacks of earth or sand; and if a few resolute men are posted in it, they will be able to do the enemy great injury by the fire of their small-arms, and by throwing large stones upon them.

OF CASTLES, FARM-HOUSES, &c.

§ 513. IF your troops are not sufficiently numerous to occupy all parts of such a building, the outhouses ought to be relinquished; and every place that can afford

* Vol. II. Sect. 3, and Vol. V.

the enemy an advantageous lodgment must be either totally, or in part destroyed; that they may not obstruct your fire. — If this is not done, all your exertions will be of little consequence,

§ 514. As almost all farm-yards and their offices are enclosed within a stone-wall, it is first necessary that you should make use of the means which have been recommended in the 498th paragraph; and wherever there are openings, hedges, or pales, they should be secured by strong palisades or parapets. — In the two last cases, a parapet may be formed with great expedition, because a paling or hedge will make it unnecessary for you to add an interior revetement. — But if the rapid advance of an enemy should not even allow you to complete such a defence; you must fill as many casks or tubs as you can find with earth or horse-dung, and place two or three rows of them in every opening*.

* See an instance of very extraordinary courage in the defence of such a place, in the sixth Vol. of my "ACCOUNT of the WAR," &c. Chap. XX. — *Author.*

§ 515. ALL wooden sheds or pales ought to be pulled down and burnt, and every useless wall must be destroyed; that they may not cover the enemy from your shot. The building itself must be put into a proper state of defence, and creneaux made wherever they will be particularly serviceable, or enable us to gain a cross fire.

§ 516. TAMBOURS or fleches should also be added to those walls, which, on account of their length or situation, cannot be completely covered by the fire from the house. Or, if time enough can be spared, small bastions may be formed before their centres and at each end.

§ 517. As soon as your troops find themselves unable to make further resistance from the walls and outhouses, they must retire into the main building. When this is to be done, two signals will be given.—At the first signal, the men who are posted in the outhouses will make an expeditious

§

retreat

retreat to the tambour which covers the entrance; and at the second, they will be followed by those from the fleches, walls, and parapets.—This precaution is of much consequence; because, if the walls were first deserted, the enemy would be in possession of the outhouses before their defenders could make their escape. If the tambour can be fired into from any of the outhouses, its top must have a strong covering of rafters, planks, and horse-dung; or, before the attack is begun, those outhouses should be unroofed, and their front walls destroyed*.

CHAPTER XXIII.

Of the Defence of Villages.

§ 518. **T**HERE are three reasons for occupying and retrenching villages.

1st. When they are at a distance from the main army, and wanted for the de-

* See Vol. VI. Chap. XX.—*Author.*

fence

fence of a few battalions against a superior force.

2dly. When they are a part of the cordon which is formed for the safety of troops in winter-quarters, or for the defence of a country : and,

3dly. When they can either keep off the enemy in an action, or oblige him to break his order of battle.— Each require different precautions : but in all essential points, their modes of defence are the same.

§ 519. (1). If a village is too far distant from the main army to be supported without much difficulty ; or if it cannot be supported at all : it may either be deemed a lost post, and its Commanding Officer directed to adhere to what has been said in the 172d and 173d paragraphs ; or it may be occupied in a case of necessity, for the purpose of gaining an honourable capitulation. In the first case, the preservation of lives is not to be considered : consequently the troops may be posted wherever they
can

can do the most mischief to their assailants, and dispute their advance step by step. But in the second, they must be kept together, and in as much security as possible; especially if they have hopes of being able to fight their way through the enemy.

§ 520. ABOVE all things it is to be observed, whether the men will be able to defend the whole village, or not.—In the latter case, they must confine themselves within the most advantageous part, separate it from the rest, and pull down every house from whence the enemy can fire upon them.

§ 521. BUT when the whole village is to be occupied, it must be as well defended as time and circumstances will allow. And if the rapid advance of an enemy should make it impossible for you to throw up works, the streets and avenues may be barricaded with waggons without their wheels, or with casks filled with horse-dung

dung or sand : for such expedients are always at hand and easily prepared.—The troops must be posted behind the walls, hedges, &c. ; and, in case they should be too high, benches, chairs, and tables may be taken out of the nearest houses, and used as banquettes. — The Commanding Officer of each post will be informed, that, in case of necessity, he is to retreat to certain houses, walls, or gardens in his rear : consequently his plan of defence at each of those places must be determined upon, before matters are carried to extremities ; that no mistake may be afterwards committed.

§ 522. As soon as the enemy is in fight, a strong reserve must be formed, under the command of an experienced officer ; by whom small bodies of men will be sent wherever they may be wanted ; either for the support of such as are likely to be overpowered, or to cover their retreat.—The church-yard, or some strong and well-situated building, will probably be the last resource :

resource : where, after an obstinate resistance, the troops can either die with glory, or make an honourable capitulation.

§ 523. WHENEVER it is possible, I would recommend that the villages should be measured by paces, and sketches made of them upon a large scale: that all the walls, hedges, ditches, or bridges, the situation of the houses, and the materials with which their roofs are made, might be accurately described. For such assistance would, at first sight, enable an experienced officer to form a general idea of his best mode of defence.

§ 524. It is by no means difficult to put a compact and well-built village into a proper state of defence. But when you meet with any of a great extent, and where the houses are at a considerable distance from each other; as in some parts of Silesia and on the mountains of Saxony, all your attempts will be ineffectual.

The

The inhabitants of a village can always be made to work, and they will be extremely useful, if sentinels are placed over them.

§ 525. (2). THE villages which are in the cordon of winter-quarters must be retrenched in front and on both sides, but left open in the rear: as well for the convenience of admitting the troops which are sent to their relief, as of facilitating a retreat, when they are no longer tenable.— In these cases works are generally thrown up and occupied between the villages; that the enemy may not force his way through or attack them in the rear. And if their distance from each other should make this impracticable, works must be thrown up behind them.

As the modes of defence and the formation of the retrenchments have been already described; I shall now only remind my readers of the necessity of employing good spies, and of using every possible precaution to guard against the dangers of a
2 surprise,

surprise, to which such posts are particularly exposed.

§ 526. (3.) As the success of an army generally depends upon the preservation of the villages which are occupied on the day of battle, it is evident that their defenders must act with the utmost resolution; and, as there can never be a want of workmen on such occasions, they may be materially strengthened in a very short time.—If the enemy should burn any of them, the flames will impede his advance; consequently, when you are obliged to desert them, they ought always to be set on fire by your own troops; unless there are very sufficient reasons to the contrary: and in that case they must be left open towards the rear, that you may be able to repel the enemy by your fire *.

* See Vol. VI. Chap. XX.—*Author*.

C H A P T E R XXIV.

Of the Defence of Towns by means of Retrenchments.

§ 527. **T**HE present mode of carrying on war must always make it less advisable for a corps to retrench itself in a town, than in a village: unless there could be a certainty that the enemy would only make his attack with infantry or cavalry.—For whenever he is attended by artillery, much labour and expence would be thrown away to no purpose. But, as such a measure may be sometimes necessary for the purpose of preventing a surprise, or of covering a magazine, I shall endeavour to explain as much as is requisite for the information of the Engineers; and leave the management of the inhabitants, and all interior regulations, to the discretion of the Commanding Officers; upon whom they must ultimately depend.

§ 528. WHEN the gates of a town have been made perfectly strong, they must be barricaded in the best manner, and banked up with earth or horse-dung, according to the 499th paragraph; and the sorties must be defended as in fig. 12, or the + fig. e, Pl. 4.

If the town is surrounded by a ditch, draw-bridges must be added wherever they may be required, and covered either by strong tambours, flèches, or traverses, as shown in Pl. 23, fig. 2, 3, 4, 5, 11, 12, 13, and 16.—All the other bridges must be at the same time destroyed.

§ 529. TRAVERSES should be formed cross the streets, and particularly near the barricaded gates; that the enemy may meet with sufficient resistance, even if he should force his way into the town.—These traverses may either be made with earth or wooden chests, as described in the 288th paragraph, and in Pl. 9, fig. 2.

In Pl. 23, fig. 15, I have formed three traverses, which extend from one side of the streets

streets to the other (*a, a, b*).—Those at *a a* are placed obliquely, that the men who defend them may not fire upon each other; and communications are supposed to be made through the corner houses, as shown by the dotted lines *d d*.

§ 530. WHEN the Austrians found it impossible to batter down the walls of Gabel with their twelve-pounders, they forced open one of its gates, upon the 15th of July, 1757, and some grenadier companies rushed into the town. But meeting with traverses in their front and on both flanks, and being fired upon at the same time from the corner houses; they were obliged to retire with very considerable loss, and the place capitulated the following day.

§ 531. EVERY opening in the walls must be well repaired with a new parapet, ditch, and palisades. And the methods of forming the embrasures, scaffolds, &c. have

been already explained in the 22d chapter.

§ 532. If the town has a ditch, it must be deepened wherever it may be necessary. And if there is none, those methods of defence must be adopted, which have been before explained in the 501st and 502d paragraphs.

§ 533. As great benefit may be derived from the old towers, which are sometimes found upon the walls of a town; no pains should be spared to increase their strength. —A cross fire must be gained wherever it is possible; and *flèches* or small bastions added, whenever the length of a line will not allow us to rake it completely.

§ 534. As soon as there is a probability that the enemy may make a breach in the wall, that part ought to be surrounded by parapets, or traverses; that he may be complimented with a cross fire at his entrance.

trance. Or, if there should not be sufficient time to form them in the usual manner, chests or casks which have been prepared and filled before-hand will answer the same purposes. When houses stand near the place, they may also be converted into block-houses, by pulling them down as far as the ground floor, and filling them at the same time with the rubbish: and if their side walls should appear to be too weak, sand-bags and fascines may be added for the security of your men.—Thus you will be enabled to keep off the enemy with grape-shot, and to save the trouble of making a traverse or parapet in front of the breach.

Some authors are of opinion that a breach might be effectually defended, provided a fire was kept burning behind it.—As a temporary defence, such an expedient may be of some use, but it is evidently too defective to be considered in any other point of view.

§ 535. WHEN there is a stone bridge in front of the gate through which a passage is to be preserved, traverses should be formed cross the streets in its front, as at *a, a, b*, fig. 16; and the houses at each end must be occupied.—Two other traverses should also be made behind the gate, with one or more pieces of cannon, as at *c*; that the enemy may meet with a warm reception if he should attempt to enter the town. And, for the sake of greater security, chevaux-de-frise may be placed between them.

§ 536. A strong post must be established within the town, as the last place of refuge, from whence the troops must make the most obstinate resistance in their power: because they will have no other means of securing to themselves an honourable capitulation. And whatever this building may be, every endeavour must be used that can tend to increase its strength.—The means of retreating to it have been already explained in the 508th paragraph.

C H A P.

C H A P T E R XXV.

*Of Lines or Retrenchments for the Defence
of an Army.*

§ 537. **I**T is perhaps a disputed point, whether such retrenchments are upon the whole to be deemed advantageous or otherwise. But, as we find that the greatest Generals have adopted the use of them; and that neither the Grecians nor Romans considered them as unnecessary, even when their armies were superior to the enemy; I think we need not hesitate to decide in their favour. And, although there are repeated instances of their having been destroyed; we have also several to prove, that the most determined troops have not dared to attack them.

§ 538. **T**HAT retrenched camps are subject to great dangers and inconveniences, is not to be denied. But I am at the same time of opinion that most of those dangers

are to be attributed to errors in their formation; and not to the mere application of such a defence.

To prove the truth of this assertion, I shall point out the grounds on which the objections to them have ever been founded.—And, when I have shown all their disadvantages; I shall explain what ought to be particularly attended to by those, who are charged with their construction.

OF THE DISADVANTAGES OF RETRENCHMENTS.

§ 539. (1st). THEY leave the enemy at full liberty to form his own plan of attack; while you must regulate your defence in obedience to it. And in general they not only oblige you to anticipate his movements, but also to counteract them by instantaneous measures.

§ 540. (2dly.) WHEN the enemy has fixed his points of attack, he can bring almost

most his whole force against it: whereas you are obliged to keep possession of all your posts, because you cannot know where the real push will be made.

§ 541. (3dly). THE assailants are generally animated with a certainty of success; while the defending party is discouraged by an idea, that the use of a retrenchment must either imply inferiority, or want of confidence.

§ 542. (4thly). As the enemy will generally be able to out-flank and surround a retrenchment; the shot which are fired from it will lose much of their effect, by being too much scattered: while you are galled on all sides by a heavy and concentrated fire.

§ 543. (5thly). WHEN the assailants have gained one part of a retrenchment, the whole is lost. Because the lines, the confined space within them, and the vicinity

nity of an enemy, will not allow you to make the necessary movements.

§ 544. (6thly). If the works are made with openings between them, a determined enemy may force his way through and take them in the rear; and, if their being joined together should enable you to beat him off, you cannot pursue your advantage.—Consequently he will either be at liberty to renew the attack as often as he pleases; or to retreat quietly, and without punishment.

§ 545. ALTHOUGH the *first* disadvantage cannot be entirely removed, great part of the danger will disappear, if we form our retrenchments so as to secure ourselves from an attack where it is not expected; and if we oblige the enemy to advance against the part where we are the best prepared for his reception.—If we can also have a reserve of picked troops, without leaving any of the works unoccupied; there will be still less to be apprehended.

As

As we ought to be particularly careful not to tie up our own hands ; the works should be constructed so as to allow us to make a sally, and to attack the enemy, whenever we may find it to our advantage to do so. But this is only practicable when they are detached from each other : as, for instance, in Pl. 24, fig. 1, 2, and 3 ; Pl. 25, fig. 1 and 2 ; and in Pl. 28.

§ 546. THE *second* disadvantage may be counteracted by means of a strong reserve, and by constructing the works so as to oblige the enemy to make his attack with a small front or in column, under a cross and flanking fire.

§ 547. It is evident that the *third* instance is principally founded on the misconduct of the defenders : yet I am convinced it may be almost always got the better of by persuasive arguments : especially when the men are commanded by officers in whom they can thoroughly confide.

When

When Wunfch's corps marched to the relief of Dresden in the year 1760, it was not supposed that the imperial Croats would have done much service ; because they were totally without shelter.—Yet such was the confidence they reposed in the heroic conduct of their leader, that they fought with the most uncommon firmness : and by that firmness, the town was relieved.—Upon other occasions, and under similar circumstances, I have also seen them maintain their ground behind a common barrier ; after it had been found that regular infantry could not withstand the violence of the enemy's attacks.

If retrenchments were in more frequent use, and if the good construction of them was evident at first sight ; their defenders would soon find out that the advantage must be decidedly in their favour. The Russians are accustomed to form their trains of artillery (exclusive of what is attached to the regiments) into a certain number of divisions ; instead of making a
park,

park, as in other services.—And when they encamp, those divisions are placed along the front, upon the flanks, or wherever their position seems to be most favourable to such a purpose; and covered by a retrenchment.—However distant they may be from an enemy, or however secure in their superiority, this is invariably the case: consequently their opponents can neither form an idea of their strength from such a circumstance; nor do their own troops suppose it to be a step taken to secure them from imminent danger.

The great Frederick himself recommends the use of retrenchments, in his “*ADVICE to his GENERALS;*” and whenever he has written against, or rejected them, it should seem that he has entirely confined his meaning to very extensive and enclosed lines. And for them, I am by no means an advocate.

§ 548. THE *fourth* disadvantage is in most cases to be avoided. For, by a judicious formation of our lines and works,
we

we can oblige the enemy to contract his front; while we are galling him with a cross fire. — This may be best effected with detached works which support each other.

§ 549. THE *fifth* objection can only hold good when we make use of inclosed, ill-constructed, and ill-placed lines or retrenchments. For it may be seen by the examples which I have given in the 24th, 25th, and 28th plans, that if the enemy should take possession of one work, he will not gain any material superiority.

§ 550. THE *sixth* objection can also be done away, if the forties are sufficiently large and numerous, and properly covered.

§ 551. RETRENCHMENTS may be divided into three distinct kinds.—First, when a position is surrounded by single works; as star-forts, redouts, and *flèches*. In that case the intervals may be left entirely
 2 open;

open; or, if palifades and trous-de-loup are placed in them, great care must be taken that they shall allow your troops to manœuvre with freedom, and to fall out upon the enemy whenever they please.— See Pl. 24, fig. 1, 2, 3; Pl. 25, fig. 1, 2; and Pl. 28.

In the seven years Silesian war, we had frequent opportunities of seeing such retrenchments. But the most remarkable of them were those of the King of Prussia near Jauernig*, those of H. R. H. Prince Henry near Liebenthal in 1759, those at Colberg in 1761†, those at Dippoldiswalde in 1759, those at Boxdorff in 1761, and those upon the high Eulen-geburge in 1762. The three last were formed by the Austrians.

§ 552. As it very rarely happens that a country is sufficiently level to enable you to place redouts, or other detached works,

* See Vol. III. Sect. 2.—*Author.*

† See Vol. V. Sect. 1.—*Author.*

with

with much regularity ; I have given the plans of some, which an Engineer can always regulate according to the nature of the ground, provided he takes care that they shall defend each other.—I will describe them in succession, and leave it to better judges than myself to determine, whether they are preferable to other retrenchments or not.—In Pl. 24. fig. 1 *, the front *a, b*, is *one hundred and twenty* toises, or *three hundred* paces in length, and the lines of defence between the redouts and the flèches, *one hundred and fifty* paces : consequently, the musket-shot will pass them in their full force.—The redouts *c* are enclosed ; and, if circumstances will admit of it, they ought to be strengthened with fraises and chevaux-de-frise : that, in case the enemy should take possession of the flèches, the most material part of the retrenchment may be still before him.—The parapets *d, e*, are formed for infantry.—Their position gives them an opportu-

* The scale which belongs to this and the subsequent plan, is annexed to fig. 1 and 2. Pl. 26.—*Author.*

nity of pouring in a cross fire upon the enemy, of taking him in the rear during his attack upon the redouts, or of falling upon him with fixed bayonets.—And, if he should be beat off, they can always retreat in security, and renew the attack as often as they please. The small flanks *i, b*, prevent their being enfiladed. — The epaulements *f, g*, not only cover the cavalry from the fire of artillery, but are made at the same time with two or three banquettes, and a ditch on the outside; that the fire of two additional lines of musketry may be gained from thence.—The fire from those ditches will be unexpected and of great service. When the enemy comes near the epaulements, the cavalry can rush out and make a sudden charge upon him.—*H* is a reserve.

The position and construction of all these works, allow the troops to move with freedom, to defend each other, and to gall the enemy on all sides with a cross fire. Each front is regulated for a battalion of 600 men, with one squadron of

horse in four divisions; and they are thus distributed.

In the flèche *a*, there are 50 men.

In the redout *c* — 200, with an *eight* or a *twelve*-pounder.

Behind the parapets *d*, *e* — 100, with two field pieces.

In the reserve *b* 200; and at the epaulement *f*, 50.

Total 600 men, and three pieces of cannon.

§ 553. IF, according to the nature of the ground, you allow such a front to each battalion, you will have a retrenched position, in which every foot of an enemy's advance may be obstinately disputed.

§ 554. THE front *a b*, in fig. 2, is also *one hundred and twenty* toises or *three hundred* paces in length. The flèches are built on a strong profile, and their gorges enclosed with palisades. They flank each other, and the redouts prevent their
being

being taken in the rear. Every redoubt has two embrasures for heavy cannon, or a raised platform for one gun: which, in that case, will be fired *en barbette*, that the faces of each *flèche* may be effectually defended.—One or two squadrons of cavalry are posted behind the epaulements *d* and *e*, with the same view as in fig. 1.

The whole of the works are thus occupied:

In the *flèche a* there are 100 men and one piece of cannon.

In the redout *c* 250, and two ditto.

At *f*, by way of reserve, 200; and at the epaulements *d, e*, 50.

Total, one battalion of 600 men, and three pieces of cannon.

§ 555. THESE works support each other, as in N° 1. But, as the loss of the *flèches a b* would be in this case of the greatest importance, they must be well supported; and, if the enemy should take possession of any of them, the reserve must immediately advance for the purpose of driving him

back.—If he should still be too powerful, a further reinforcement may be drawn from one of the adjoining fronts or battalions; and, as none of the reserves are more than 300 paces afunder, this may be soon effected.—In all these attacks much will be expected from the cavalry.

§ 556. THE front *aa*, in fig. 3, measures *three hundred* paces: consequently, more than is requisite for a battalion of *six hundred* men in line.—These *flèches* cannot defend each other; therefore they must be covered by the first row of redouts in their rear (*bc*), and those again by the second (*dd*):—And, as the lines of defence are not above *two hundred* paces in length, this may be done as well by musketry as artillery.—If the gorges of the *flèches* are not left open, they ought only to be enclosed with palisades.

In the *flèche a* there are 50 men.

In the redout *b* 200, and one gun.

In the redout *d* 200, and two ditto.

As a reserve 200.

Total

Total 650 men, three pieces of cannon, and one or two squadrons behind the epaulements *e f.* Or, in this case, the reserve might be posted at each epaulement and in its ditch.

§ 557. THE lines of fire show how much these works support each other, and the extreme danger to which an enemy must be exposed; whenever he may venture to make an attack upon them.

§ 558. IF the movements of the reserves of infantry in fig. 2 and 3, are at all likely to interfere with the cavalry, they may remain some paces further in the rear.

§ 559. THE front *a b*, in Pl. 25. fig. 1, is also *three hundred and thirty* paces in length; but the lines of defence are not above *eighty* toises or *two hundred* paces: consequently, the flèches can be supported by musketry from the redouts.—The parapets *d, b* are thrown up in the form of a flèche, with two embrasures and a traverse

to defend the fortie. The musket-shot which are fired from hence will reach those from the redouts at the distance of 100 paces. — Two rows of palifades are placed between the flêche *a*, and the parapets *db*, that the defenders may be able to make a safe retreat; or a double parapet might be formed for the same purpose. But, in that case, the assailants would have a more favourable opportunity of following the defenders, and of forcing their way within the parapets. — If infantry are posted at the epaulements *fg*, they will be of great use in supporting the redouts and parapets in their front.

In the flêche *a* there are 50 men.

In the redout *c* 250, with one or two pieces of cannon.

Behind the parapets *db* 200, with two ditto *.

At the epaulements *fg* 100.

Total 600 infantry, with three or four

* If there should be a scarcity of artillery, these *two* pieces of cannon might be omitted. — *Author*.

guns.

guns.—One or two squadrons of horse are posted behind the epaulements.

§ 560. As no allowance is made for a reserve, in the distribution of the troops for the defence of this retrenchment (fig. 1.); the two hundred men at *d b* will charge the enemy, under the support of the cavalry: in case he should attack the redout *c*.

§ 561. IN fig. 2, the works are larger, formed *en cremaille*, and enclosed with palisades.—The epaulements at *d* are thrown up for cavalry, and, if it is practicable, they ought to be supported by one hundred infantry.

In this case the troops may be thus divided.

In the small tenaille *a*, 100 men.

In the large ditto *b*, 400, with two or three pieces of cannon.

And behind the epaulement *d* 100.

Total 600 infantry, two or three pieces of cannon, and two squadrons.

§ 562. THE above-mentioned retrenchment is extremely serviceable in a flat country, if you have a sufficient supply of cavalry; or wherever there are many small heights with gradual ascents, which lie near each other. Every *tenaille* defends itself with a rectangular and cross fire, and each is an effectual support to those which are near it.

The double *tenailles* *bc* are supposed to have large openings, and those openings guarded by *chevaux-de-frise*; that some hundreds of their defenders may be able to rush out and charge the enemy, whenever they find it advantageous to do so*.

§ 563. THE *second* species of retrenchment which I shall take into consideration, is formed by enclosed lines.—With these an Army or Position may be either surrounded, or merely defended in front.—Of the latter kind, some were very advan-

* See a fuller account of these works, and their use in order of battle, in the sixth Vol. of my ACCOUNT of the WAR, &c. Chapters XVIII. and XXIII.—*Author*.

tageously

tageously formed by H. R. H. Prince Henry, at Strehlen, in the year 1759, and at the Katzen-Haufern, in 1760. — In all cases, such retrenchments must have several well-defended forties : and, as their fronts are seldom or ever to be made with regularity, the Engineers will be generally obliged to form their angles as the ground will allow them,

§ 564. PL. 25. fig. 3, represents an entire line of tenailles, whose salient angles *a* and *b* are *one hundred toises* or *two hundred and fifty paces* asunder. — To form them, you must erect a perpendicular, as at *b e*, upon the centre of the base *c d*; let its length be thirty-three toises and an half, and join *b d* and *b c* together. The forties should be made in the reentrant angles, and covered by traverses, as at *d*.

§ 565. FIG. 4, is an indented line with bastions, whose entire front is *one thousand paces* in length : consequently, the distance from *a* to *l* will be *five hundred paces*.

The

The gorges of the bastions may be enclosed with palifades, and the forties made as at *e*.—To form such a retrenchment, you must first mark out your base, divide it into two equal parts, and erect a perpendicular at each end and on its centre.—*L k* represent the perpendicular on the centre of the base, and *a f*, that at one end; to which *thirty-five* toises are given for the height of the bastion.—From the point *f*, you must set off *twenty* toises to the right, and *twenty* to the left. Let the perpendiculars *l k*, *m o*, *i b*, and *c d* be *thirty* toises asunder, and *fifteen* in length; then set off *five* toises from *c* to *e*, from *b* to *p*, &c.; and draw the lines *a d*, *d e*, *e i*, *i p*, *p m*, *m n*, and *n l*.

§ 566. FIG. 5 and 6, represent lines of bastions; and the curtain of the latter is made with a salient angle, which increases its defence.—Their fronts are *three hundred* paces in length, and their construction may be seen in the plan.

§ 567. FIG. 1 and 2, in Pl. 26, represent two lines with lunettes or *flèches*; from whence the communications are formed by means of a double and sunk parapet.

The front *a b* is *one hundred and twenty* toises in length, the perpendicular *c d* *twenty-five*, and *d e* *eighteen*. In fig. 2, the perpendicular *f e* is *thirty-five* toises in length; *a c*, *twenty*; *c d*, *twenty-five*; and *c g* is perpendicular to *d g*.

These enclosed lines are taken from M. de Clairac, where several other examples are to be found, and all of them will admit of various alterations*.

§ 568. UNDER the *third*, are comprehended those entire lines, which are frequently several miles in length, and formed for the purpose of covering a tract of country. But, as they are now rejected by the greatest Generals, in consequence of their known imperfections, I shall not pre-

* See the attack and defence of such lines in the sixth Vol. of my "*ACCOUNT of the WAR,*" &c. Chap. XXII. Plans 11 and 12.—*Author.*

fume to say any thing in their defence : and I therefore conceive it unnecessary for me to enter into a description of them.

§ 569. IN the second part of Turpin's Commentaries upon Montecuculi, we find seven different methods of retrenching a camp : all of which come under these three general heads. 'And, if I was to introduce an account of them, I should go beyond the limits of my work ; without adding much to the instruction of those officers for whom it is principally intended. For, in the first place, there are only the third and fifth, which could be of much service at any time ; and secondly, we know that much more attention must always be paid to the nature of the ground in the formation of a retrenchment, than to any regular or studied system *.

§ 570. IF a corps is posted at some distance from the main army, and a commu-

* See Vol. VI. Chap. XXIV.—*Author.*

nication

nication is to be kept up between it and another post or magazine; or if the enemy's vehemence is to be checked by the strength of its position: it must be well retrenched, its flanks must be free, and, that it may not be cut off, the roads and debouchés which lead towards the army must be put into a good state, that there may not be the least hinderance to a retreat.

§ 571. PL. 27 shows the retrenchment of a corps near Welkersdorff, when detached from H. R. H. Prince Henry's army at Krommen-Oelfe, in the year 1759; by which, the subject of the preceding paragraph may be much better understood, than by any explanation I could give.—The two roads of communication which passed through the wood, were covered with stems of trees in the completest manner; and at their debouchés, there were palisades, barriers, and a tambour. The road to Krommen-Oelfe was defended by a *flèche*: the others,
by

by abbatis on both sides and towards the rear.

§ 572. I SHALL now endeavour to give a more complete explanation of what I have hitherto said of retrenchments, and of the rules which are to be attended to in their formation; by representing a country, with the retrenched position of an army upon it *.

§ 573. IN August 1761, the King of Prussia was about seven or eight thousand paces from Schweidnitz; with his right wing appuyed to Tzfschechen, and his left immediately behind Buntzelwitz, Zedlitz †, and Jauernig; Pl. 28, D.—The Austrians and Russians threatened an attack, and encamped in the following manner:—A corps consisting of 4,000 Austrians and 8,000 Russians, under the orders of Ge-

* In the ninth part of the German Kriegs-Bibliothek, see a description of General Count Basta's camp near Weizen.

Author.

† The plan shows that Zedlitz must have been in front of his right wing.—*Translator.*

neral Beck, encamped with its left towards Nickalsdorff; and Grunau lay in front of its right wing, c. The Ruffians, under General Czernichef, were upon the right and left of Striegau, with the village of Stanovitz in their front, B.—The Austrians, under General Laudon, were posted with their left towards Zirlau, and their right at Boegendorff, A.—Wilkendorff and Arnisdorff lay in their front.

§ 574. By this position the front and right wing of the Prussians were surrounded by the enemy : and, as it was very probable that General Beck would march by Peterwitz and Neudorff, for the purpose of falling upon their rear; the whole army was retrenched within lines, which (including the curves) were *thirty - nine thousand* paces, or about *eighteen* miles, in length. These retrenchments were extremely strong, and in some parts defended by fougasses : but, notwithstanding their strength, General Laudon was very desirous of attacking them, and would undoubtedly

doubtedly have done so, if he could have prevailed on the Russians to assist him.— This delay gave the King an opportunity of quitting his encampment, and Schweidnitz; and General Laudon took immediate possession of them.

§ 575. I WILL now suppose an army of FORTY THOUSAND men to be exactly circumstanced as the Prussians were at that time; with their provisions, ammunition, and flying hospital in Schweidnitz; threatened with an attack by an enemy of twice their strength, and with the loss of all their magazines, &c. in that town, in case they should be obliged to retreat.

FIRST REMARK.

§ 576. I MUST here beg leave to observe, that I neither have an idea of finding fault with the Prussian retrenchments by this supposition, nor the presumption to correct them.— The plan of defence which I shall propose for this army, is merely intended to show the application of the

the rules which I have before laid down, and to explain the methods of taking up such a position, as the nature of the country and other circumstances may require.

S E C O N D R E M A R K.

§ 577. As this position of the Prussian Army, and General Laudon's plan of attack, are fully explained in the third volume of my "*ACCOUNT of the WAR,*" &c. I must refer my readers to it.—They are particularly instructive—and, if each side of the ground is taken separately into consideration, viz. from Zedlitz to Peterwitz, from Peterwitz to Wurben, from Wurben to Buntzelwitz or Jauernig, and from Jauernig to Zedlitz, a few trifling alterations might make those retrenchments applicable on an hundred different occasions.

§ 578. THE heights near Tzfschechen, (which the Prussians had also retrenched), are throughout advantageous : whether retrenchments are thrown up, or whether

the enemy is received without them. But, as I suppose my whole army to consist of no more than *forty thousand* men; from which number, a corps of *six thousand two hundred* will be detached and posted near Sabischdorff, to keep up a communication with Schweidnitz; it would be impossible for me to occupy retrenchments of so considerable an extent.—It is also to be supposed that I have sufficient time for the formation of all my works, and that my army is not yet surrounded by an enemy. And lastly, it is to be supposed, that the enemy may be expected on all sides; or, at all events, that his principal attack is uncertain.—Consequently, my whole position must be of equal strength.

Whatever wood I may stand in need of, must be brought from the Nonnen-Wald, and the other neighbouring forests: that such as are within the line of my retrenchment may be spared as much as possible.

§ 579. My whole army is thus composed:

31,000

Of Lines for the Defence of an Army. 163

31,000 infantry,

4,500 cavalry,

1,000 huffars, and

3,500 { men belonging to the free-
corps.

Total 40,000.—Out of which number there will be a corps at Sabischdorff of

5,000 infantry,

500 cavalry,

500 belonging to the free-corps,

and 200 huffars.

Total 6,200.

Consequently, there will remain in the main army 26,000 infantry, 4,000 cavalry, 800 huffars, and 3,000 belonging to the free corps.

§ 580. THE detached corps will occupy the villages of Sabischdorff, Zultendorff, and Roth-Kirschdorff. One of its flanks will be covered by the river of Schweidnitz, and the other by the ravines of Sabischdorff and Zultendorff.

§ 581. IF I have a just recollection of the ground, the river of Schweidnitz might be dammed up from the town of Schweidnitz to Wurben; by which means an attack on this corps would be impracticable: but I do not affirm this to be a certainty. Or, if an inundation could be formed with the rivulet which passes through Schoenbrun, Kammerau, the ravine of Sabischdorff, and Zultendorff, without destroying those places, it would be still more convenient.

§ 582. THE ground between Sabischdorff and the river of Schweidnitz ought to be retrenched in the strongest manner; and either fig 1 or 3, in Pl. 24, might be made use of for that purpose.—If the enemy should fall upon this detachment with all his force, it can be soon reinforced by some thousand men from the reserve of the main army, who will endeavour to gain his flank or rear. Or, if he confines his attack entirely to the main army, it will be of very great service in taking him in the rear.

If

If this corps should be obliged to give way, it can retire under the batteries of Schweidnitz. But this is not very likely to happen: because, as the whole distance from Wurben to Schweidnitz does not exceed *nine thousand* paces, another reinforcement could be sent from thence with as much ease and expedition as from the main army. —We are also to consider, that, unless the enemy sends a body of troops round the whole position, or on the other side of the town; he can only make an attack upon one flank, while both his own will be exposed.

All this part of the country may be seen in the extract from one of the provincial maps of Silesia, which I have added to the plan.

§ 583. THE hussars of the main army must be posted in the villages which lie without the retrenchments, and keep patrolling outwards as far as possible: that they may discover all the enemy's movements.—Small bodies of six or eight men

must be dispersed at the same time within the lines, for the purpose of carrying intelligence and reports to the officers who command the different posts.

§ 584. THE free battalions may be divided in the following manner :

FIVE HUNDRED men in Wurben. A village which is particularly well calculated for such troops ; because it abounds in brush-wood, large ponds, and ditches.—It has also several gardens, a large yard with out-buildings, and a church of uncommon size ; which are not only joined together, but surrounded by high stone walls.—This post must be defended to the last extremity, and well supported by the main army. And, when it cannot make further resistance, the troops may retreat through the palisades between N° 2 and 3.

§ 585. TWO HUNDRED men in Neudorff, where there is a large house and garden : both surrounded by a stone wall.—This post must also be reinforced from the retrenchments ;

trenchments ; and, in a case of absolute necessity, it may be permitted to retire in small bodies through the forties, N° 11, 15, and 17.

§ 586. TWO HUNDRED men in Peterwitz. But, as this post will be about *two thousand five hundred* paces from the retrenchment, it would scarce be possible to support it.—It's defenders ought therefore to be composed of volunteers, who are determined to make a most obstinate resistance (§ 519) ; or, if possible, to cut their way through the enemy, and retire between N° 22 and 23, to N° 25.—In this village such a body of resolute troops might hold out for a considerable time ; especially if one or two hundred men were sent to their assistance from the reserve, and entirely given up to their fate. For, exclusive of a walled churchyard, it has a castle ; which, together with its out-buildings, are surrounded by a mote and a very strong wall.

§ 587. FIFTY men in Puschkau, with *fifty* hussars. In this village there is a walled church-yard, and a very large farm-yard surrounded by a stone wall. But, as it is at too great a distance to be supported, these men must retreat to Tzschechen or Peterwitz, at the approach of an enemy ; or, if this should not be practicable, they will throw themselves within the abbatis at N° 23.

§ 588. THREE HUNDRED in Tzschechen. This village has no church, but there are two large yards in it surrounded by walls ; and when its defenders find themselves unable to make further resistance, they will retreat through the debouché below N° 28.—Tzschechen is not within *three thousand* paces of this work ; consequently it will be necessary to send out such a body of men to cover their retreat, as the strength of the enemy, and the nature of his troops may require.—In the retrenchment of this place, attention should be paid
to

to the rules which I have laid down in the 525th paragraph.

§ 589. TWO HUNDRED in Zedlitz.—This village has neither a church, a castle, nor a garden wall: but, as all the houses have high and favourable situations, the troops might hold out some time. And its position would make it extremely difficult for an enemy to bring artillery against it.—When this post is no longer tenable, the troops can make good their retreat between N° 39 and N° 41.

§ 590. THREE HUNDRED will be posted behind several abbatis in the wood of Zedlitz, for the purpose of checking the enemy, in case he should attempt to force his way through it, or to cross the rivulet.—To the best of my recollection, this part of the ground is too flat to admit of an inundation; but if the water could be dammed up, so as to make it even swampy, much would be gained: because this side would then be secure against cavalry and artillery.

When

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When

When these troops are repulsed, they will retire under cover of the works, between N° 42 and N° 47.

§ 591. FIVE HUNDRED in Jauernig. This village has a well-situated church, within a circular wall; which ought to be made as strong as possible.—These men, and the troops at Wickendorff, will support each other reciprocally; and, as the houses extend as far as the main retrenchment, their retreat to N° 63 cannot be cut off.

§ 592. FIVE HUNDRED men in Buntzelwitz; where there is a church in the centre of the village, and a walled churchyard that may be easily defended: because no houses are built against it.—This place cannot be attacked till the enemy has taken possession of N° 68 and 69: consequently it may either be used as headquarters, as a magazine, or for the lodgment of stores, &c.

In case this post should be attacked, the army will support it to the utmost; and a
retreat

retreat must not be thought of unless it is set on fire. If the enemy should be able to make a lodgment upon the heights 68 and 69, the burning of this village will be his first attempt, and he may probably succeed in it. But as he will be unable to advance, while the houses are in flames; our troops must be prepared to occupy it as soon as possible, and to repel his troops wherever they may find them. The retreat of these troops will be made behind N° 70.

§ 593. TWO HUNDRED men will occupy Teichenau; where there are several stone walls, and a large house, situated upon an island in the middle of a lake, and surrounded by a strong wall.—At any rate this post must be maintained, in obedience to the 172d and 173d paragraphs, because it forms a part of the communication with the corps at Sabischdorff; and whenever it is attacked, the troops at Roth-Kirschdorff will endeavour to gain the enemy's rear,

§ 594.

§ 594. As all these villages must be retrenched according to the rules which I have given in the 23d chapter; a sufficient number of Engineers, or other officers who are well acquainted with that branch of military science, will be sent from the main army for that purpose.

Whenever the light-armed troops shall be obliged to retire within the retrenchments, they will be of very great use in making sallies upon the enemy during his attacks.

§ 595. THE works and posts for the main body of the army are thus regulated.

N^o 1, is formed for *six hundred* men. This, as well as every other work, is constructed according to the nature and situation of the hill on which it stands, and its rear is formed with palisades; both for the purpose of saving labour and expence, and of keeping the enemy under the fire of our artillery, after he is in possession of it. And, as this is the most elevated part of the whole position, a slight wooden beacon should

should be built upon it; that we may discover the enemy's attacks, and know when any of the posts stand in need of support.—The same kind of beacon may be placed upon N° 28, and upon the Farben-Hohe at N° 57.

The flèches N° 2, 3, and 4, contain *fifty* men each: they are in part joined together by palisades, and in part by trous-de-loup.

N° 5, is a tenaille for *three hundred* men.

The epaulement N° 6 is made with banquettes, to enable musketry to rake the débouché. This work is defended by *one hundred* infantry; and behind it there are *five* squadrons of horse, who, in case of an attack, will charge through the opening and take the enemy in flank.

At N° 7, there will be *two hundred and fifty* men. This work must be well built, and strengthened by a fougass.

N° 8, is made for *fifty* men. The position of this work will render an approach on this side very difficult, and it will have an
entire

entire command over the declivity of the hill. It is joined with palifades to N° 9.

N° 9, for *two hundred* men.—As the projected situation of this work may expose it to an attack, I have enclosed all its sides; and it ought to be strengthened at the same time with palifades, fraises, trous-de-loup, fougasses, and whatever may tend to obstruct the enemy.

N° 10, for *one hundred* men; and N° 11, for *fifty*, with *three* squadrons.—To save labour and men, these and the following works are joined together by trous-de-loup. And, as I shall have a strong reserve of infantry and cavalry, this may be done without danger: because they will be in constant readiness to fall upon the enemy, whenever he may attempt to fill them up, or to force his way through.

N° 12, is formed for *one hundred* men. The rear sides of this redout are only enclosed with palifades; that the enemy may find himself exposed to an unforeseen fire, in case he should have driven them back,
and

and had the courage to pursue them through the debouché.

N° 13, contains *three hundred* men. This work ought to be very strong, and its gorge is enclosed with palisades.

N° 14, is made for *three hundred* men. This work is placed opposite the debouché, between 13 and 15, with the same view as N° 12: and, as it is also serviceable in supporting the retrenchment near Buntzelwitz, I have enclosed it on all sides, and strengthened it with fraises and palisades.

N° 15, for *two hundred* men, and *two* squadrons. These squadrons are posted with the same view as those at N° 6.

N° 16, for *three hundred* men. This enclosed redout will rake the ground within the lines, in case the enemy should have penetrated within them.

N° 17, for *three hundred* men, and *three* squadrons.

These bastions are very strong; and an opening is left between this work and N° 18, that my infantry and cavalry may
be

be able to fall out upon the enemy, and take him in flank and rear.

N° 18, for *three hundred* men.—As this is one of the most important posts in the whole position, it ought to be of great strength, and well supplied with artillery. The abbatis, which extends from hence to N° 27, is formed according to the rules that have been given in the 17th Chapter.—None of these posts should be left without heavy cannon.

N° 19, for <i>one hundred</i> men,	} to defend
and	
N° 20, for <i>two hundred</i> men	} the abba-
N° 21, for <i>two hundred</i> men,	} The im-
and	
N° 22, for <i>one hundred</i> men.	

portance of these posts makes it necessary that they should be strengthened to the utmost.

N° 23, is a star-fort for *five hundred* men; and constructed according to fig. 1. Pl. 16. This height lies near the army, and commands N° 22, 24, and 26: consequently, the work upon it ought to be made as strong as possible. (§ 141.)—And, as the
retreat

retreat of these troops must be attended with extreme difficulty to themselves, and danger to the whole army; the Commanding Officer should have orders to defend himself to the last extremity.

If he should be allowed to retire, he must endeavour to reach N° 25.

N° 24, is formed for *one hundred* men; and N° 25, for *two hundred* men.—These works defend the abbatis.

N° 26, for *five hundred* men.—As this is a post of great importance, I have added a fougass, and enclosed its gorge with an abbatis.

N° 27, for *one hundred* men. A flèche which terminates the abbatis.

N° 28, for *five hundred* men, and *five* squadrons.—This important work is enclosed on all sides, and formed according to the contour of the height.—The *five* squadrons are posted in security, and are at the same time ready to charge the enemy through the debouché.

N° 29, for *three hundred* men. An enclosed redout formed for the purpose of

raking the debouché, and of supporting the works, N° 30, 39, 40, 41, 42, and 43.

N° 30, is a half redout for *one hundred* men.

N° 31, a post of importance for *three hundred* men.

N° 32, for *one hundred* men, } These sin-

N° 33, for *one hundred*, } gle redouts

N° 34, for *fifty*, } and flèches

N° 35, for *one hundred*, } will be ex-

N° 36, for *fifty*, } pected to

N° 37, for *fifty*, and } make a ve-

N° 38, for *fifty*. } ry obstinate

defence; because they support each other, and can be assisted at the same time by cavalry and infantry from within the trenchment.

N° 39, for *one hundred* men, } These are

N° 40, for *fifty*, } single works

N° 41, for *one hundred*, and } with trous-

N° 42, for *fifty*. } de-loup in

their front.

N° 43, for *fifty* men, and } These and

N° 44, for *fifty*. } the following

works, as far as N° 46, are joined together by a double row of palisades, placed according

according to the 294th paragraph.—If there are a sufficient number of abbatis in the wood of Zedlitz, and if the river below is dammed up, the principal attack will not be made on this side, because the enemy cannot bring up his artillery. And if he could, it would be of very little service, on account of the height of this ground above the ravine.

N° 45, for *three hundred* men. An enclosed redout which supports all the works from 29 to 49, and can rake the ground within the retrenchment.

N° 46, for *fifty* men. As this small height is not commanded by any in its front, I have only surrounded the summit with palifades.

N° 47, for *fifty* men, and } Their gorges
N° 48, for *fifty*. } are enclosed
with palifades.

N° 49, for *three hundred* men. This enclosed redout commands the debouché below N° 57, as well as the ground in its rear; and supports the redout 45, with all the works from thence to 51, and the post at 57.

N° 50, for <i>fifty</i> men,	} These works are formed according to the ground, and joined toge- ther with pali- sades.
N° 51, for <i>one hundred</i> ,	
N° 52, for <i>fifty</i> ,	
N° 53, for <i>fifty</i> ,	
N° 54, for <i>fifty</i> ,	
N° 55, for <i>fifty</i> , and	
N° 56, for <i>fifty</i> .	

N° 57, is formed for *four hundred* men, and *two* squadrons. This work is placed upon the Farben-Hohe. It supports all those which have been described after N° 45, and commands a great extent of ground within the retrenchment. These two squadrons can charge the enemy through the debouché below N° 51.

N° 58, for *three hundred* men. This work will be of the same use as 57; and, as it forms a salient angle of the retrenchment, it must be strengthened and supported to the utmost.

N° 59, for *five hundred* men. This post is immediately exposed to the enemy's attack: consequently it ought to be composed of picked troops.—It must be well supported by the main army, and by the
five

five hundred men of the free-corps from Jauernig. The part of Nieder-Arnsdorff which joins to it, is entirely burnt down, and the materials removed : that the fire from the work may not meet with any obstruction.

N° 60, for *three hundred* men. This is a sunk work formed round the lower part of the hill, for the purpose of raking the village and the ground near it with a horizontal fire.

N° 61, for *one hundred* men. This redout occupies the summit of the same hill, and can fire with safety over the work below.

N° 62, for *four hundred* men. This is also a principal post, and must be supported to the utmost ; not only from N° 60, 61, and 65, but by the infantry and cavalry of the reserve.

N° 63, for *one hundred* men. This parapet covers the debouché, and *five* squadrons are posted behind it : for the purpose of making a vigorous charge upon the enemy, as soon as the fougasses have

been sprung in front of N° 62; or in case he should attempt to pass the trous-de-loup.

N° 64, a *flèche* for *fifty* men.

N° 65, for *four hundred* men. This enclosed work commands the ground on all sides.

N° 66, a *flèche* for *fifty* men, and

N° 67, an enclosed redout for *three hundred* men. These rake the ground on all sides, particularly the debouché of Buntzelwitz, and support the works that lie near them.

N° 68 is formed for *two hundred* men, and

N° 69, for *four hundred* men.—These works must be made as strong as possible, and their gorges left open towards the village. The troops in them will fight as long as they are able; and, as they will have the satisfaction of knowing that their retreat cannot be cut off, much will be expected from them.—During an attack, the *five hundred* men of the free-corps who are posted in Buntzelwitz will fall out, and

and harrafs the enemy on all fides. In a case of extreme neceffity they can all throw themselves into the village.

N° 70, is a flêche for *fifty* men, and

N° 71, an enclosed redout for *three hundred* men. These works support Buntzelwitz, as well as those which lie near them, and command the ground within the retrenchment.

N° 72, is a flêche for *one hundred* men.

N° 73, a redout for *three hundred*.

N° 74, a redout for *three hundred*.

N° 75, a flêche for *one hundred*.

N° 76, a flêche for *one hundred*, and

N° 77, a flêche for *one hundred*.

These works defend each other, all the debouchés of Teichenau, and the ground in their rear.

At N° 78 there are *three hundred* men,

At N° 79 - *two hundred*,

At N° 80 - *two hundred*,

At N° 81 - *two hundred*, and

At N° 82 - *three hundred*; for the defence of the abbatis.

Total, FIFTEEN THOUSAND men.

Consequently, there will remain *eleven thousand* for the reserve of infantry.

R E M A R K.

§ 596. ALTHOUGH I have only allotted *one hundred* men to several of the redouts, it is not to be supposed that their interior spaces have been calculated for that number, according to the rules given in the 322d paragraph.—The defence they afford to each other, the strength of the reserve, and the improbability of their being taken in the rear, make it only necessary for two of their sides to be occupied at the same time : I have therefore made them of *thirty, thirty-five*, and even of *forty* paces in length.

§ 597. A BOARD must be put up at each work, with its number marked upon it ; both as a guide for its own men, and for those who may be sent to reinforce it. And, to avoid confusion in case of a surprise, the troops must either remain in
their

their respective works, or pitch their tents near them.—The divisions will of course be made as soon as the position is taken; and whenever a beacon is set on fire, or a signal observed either at N° 1, 28, or 57, the men will immediately repair to their parapets, without waiting for further orders.

THE DISTRIBUTION OF THE RESERVE OF
CAVALRY.

§ 598. EACH squadron is supposed to consist of ONE HUNDRED men.

At N° 84, *five* squadrons support those at 11, 15, and 17 :. and the *five* squadrons at N° 86, may be used for the same purpose, provided there is nothing to apprehend towards Jauernig.—If the enemy should break through the abbatis, they must not give him time to form.

At N° 85, *five* squadrons support those at 28; that part of the abbatis from 24 to 26; and all the works from 32 to 49.

At N° 86, *five* squadrons support 57, 63,
and

and the rear of the works from 58 to 70.

Total, FIFTEEN squadrons, or ONE THOUSAND FIVE HUNDRED men.

§ 599. THESE squadrons are not meant to be tied down to any particular post, but they are to lend their assistance wherever it may be wanted : and the Commanding Officer of each work must know where he is to make his application in a case of necessity. — Whenever the enemy has got within the lines, they must either leave it to the infantry to take prisoners, or cut down every man. And when they go out of the lines, they will take equal care not to pursue too far ; lest they should be driven back by his cavalry, and followed into the retrenchment.

DISTRI-

DISTRIBUTION OF THE RESERVE OF
INFANTRY.

§ 600. AT N° 87, there are *one thousand* men, for the support of all the works from N° 1 to N° 10.

At 88, *five hundred*, to cover the opening below N° 11, and to support 12, 69, 70, and 71.

At 89, *one thousand*, to cover the débouché near N° 15, and to support the works at 13, 14, and 15.

At 90, *one thousand five hundred*, to defend the débouché below 17, and to support the works and abbatis from 18 to 24.

At 91, *one thousand five hundred*, to continue the support of the abbatis from 24 to 27.

At 92, *one thousand*, to cover the sortie, and to reinforce all the works beyond it.

At 93, *one thousand*, to support all the works from 39 to 45.

At 94, *five hundred*, to keep up the support from 45 to 49.

At

At 95, *one thousand five hundred*, to defend the debouchés near 57 and 63, and to support all the works between them.

At 96, *five hundred*, to defend the débouché of Buntzelwitz, and to reinforce the works on each side of it. And,

At 97, there are *one thousand* men, to defend the debouchés of Teichenau, and the height of Wurben.

Total ELEVEN THOUSAND men.

§ 601. NONE of these bodies of infantry will attempt to support any parts of the retrenchment, beyond those to which they are allotted: unless they receive an express order to do so.—Because, in case of a false alarm, they cannot regain their posts so expeditiously as the cavalry.

§ 602. THE retrenchment of the villages will be regulated according to the 22d and 23d chapters; and the profiles of the works will be greater or smaller in proportion to the probability or improbability of their being attacked by artillery.—But, as
all

all the posts at the advanced corners of the position are of very great importance, they must be made particularly strong; defended by palisades, fraises, trous-de-loup, and fougasses; and amply provided with the heaviest pieces of ordnance.

§ 603. It is now evident that the enemy cannot attack any part of this position, without being exposed to a heavy and cross fire; that he must entirely lose the advantages of a large front; and that his flanks must be exposed.—And, if he should have forced his way through the line of my retrenchment, or taken any of the posts, it is equally evident that he will find his progress checked by an enclosed redout, till my reserves of cavalry and infantry will have had time to assemble, and to make him pay dear for his temerity.

P A R T III.

OF TAKING UP GROUND, AND THE PRE-
PARATION OF MILITARY PLANS.

C H A P T E R I.

Of the Preparation of the Scale.

§ 604. **W**HETHER a country is measured by paces or merely taken up by the eye, a scale must be added to the plan : otherwise it will be extremely imperfect, or perhaps I might say, almost useless. Such a scale can always be made from a map of the country, and it is not to be supposed that an Engineer would undertake such a business without one.

§ 605. **W**HEN this is to be done ; you must first determine the intended size of the plan, and then mark all the principal
§ places

places upon your paper in their new proportion.—This may be accomplished either by means of triangles or squares *. However, the easiest and most certain method is to enlarge your scale according to even numbers ; that it may be *two*, *four*, *six*, or *eight* times as large as that of the map. And if you then divide it into paces, you will be able to give a distinct representation of the nature of the ground, as well as of every small object that has been before omitted.

§ 606. A SCALE is formed by dividing a given line into miles, yards, paces, feet, &c.

If, for instance, the whole length of a line is *four thousand* paces ; you must first divide them into *four* equal parts ; the first of those parts into *ten*, for the hundreds ; the first hundred into *ten* ; and the first tenth again into *ten*. Thus the thousands, hundreds, tens, and single paces will be

* See the twenty-fifth chapter of the third part of this work.
Author.

expressed.

expressed. But when more minute divisions are requisite, I would recommend the use of transverse scales; whose construction and superior advantages may be so clearly seen in the 26th plan, fig. 3, and in most of the plates annexed to this work, that a written description of them is totally unnecessary. — I shall therefore content myself with observing, that, as a pace is of no established length, it need only be shown how many of them will make a mile, and of what kind that mile is supposed to be. The tables I, II, III, and IV, give the length of the miles and measures in different countries, as well as the exact proportion they bear to each other.—For the uncertainty of the seat of war must always render such information extremely necessary: especially for those who are to execute the duties of an Engineer.

CHAPTER II.

*Of taking up Ground WITH the Help of
a Map.*

§ 607. **I**N addition to the usual methods of making a plan from a map* by means of squares or triangles, as mentioned in the 605th paragraph: there still remains a third (the invention of a friend of mine), by which its contents may be increased to any degree, and carried upon a separate sheet of paper with more ease and equal accuracy.

When lines have been marked between the principal objects in the map, as represented by *a, c, b, f, e*, in Pl. 31, fig. 2; you must fix it and your sheet of paper upon a table, and draw the main line *A, B*, fig. 1, parallel to *a, b*, and as much longer as may be necessary. Then make *A C* parallel to *a c*; *C B* to *c b*; *A E* to *a e*; *E B* to *e b*;

* See the methods of enlarging and reducing plans in the twenty-fifth Chapter.—*Author.*

A F to *a f*; and B F to *b f*.—Thus the intersection of the lines will mark the exact position of the objects *a, c, b, f, e*, and the point D is either to be found by drawing C D parallel to *c d*, or A D and B D parallel to *a d* and *b d*. — By the same means the smallest plan of a fortrefs may be increased and transferred almost without the use of a compass.

§ 608. As the generality of maps merely show the principal objects, the Engineers can only put down the chief windings of the rivers, and mark the points where villages are to be drawn. Remembering at the same time that those in the maps always represent the church or some other conspicuous building. When they are upon the ground they will fill up their sketches. —And although there are some maps wherein the ground is in great measure expressed, as well as the length and shape of the villages; it is still necessary that they should be attentively compared with the country, and all inaccuracies corrected:

for it may be taken for granted that the best of them are by no means free from errors.

§ 609. THE compass must be drawn on a corner of the paper, or wherever it will not interfere with the plan. And, instead of expressing all its different points, I would recommend that only two cross lines should be made use of, as in the 29th plan ; for in a military plan that will be quite sufficient.

§ 610. WHENEVER the form of the ground will admit of it, the upper part of the plan should mark the north : but this cannot be considered as a general rule ; for in those of encampments or positions, the whole must be regulated by the front.— The common rules of light and shade must be also disregarded ; because it is always supposed that the light comes from the upper corner of the left hand side.

C H A P T E R I I I .

*Of taking up Ground WITHOUT the Help of
a Map.*

§ 6II. **I**F it should accidentally happen that an Engineer is obliged to draw a plan of a country, of which he has no map, he may proceed in the following manner.

We will suppose, for instance, that he has pitched upon the villages A, B, c, in the 29th plan, for his first triangle; and that he has been informed by the people of the country that A is *three* miles distant from B; and that c is *two* from A and *two* from B. But, as the road is found to wind considerably between A and B, he must make a proper allowance; and place them perhaps two miles and a half asunder. Having then taken *two* miles off his scale, he will sweep two arcs; the one from A, and the other from B: and their intersection will show the position of c with tolerable

accuracy. In this manner he will proceed; always using a given line between two villages as a base for his other triangles; till the whole is completed.—If he should think it necessary to measure any of the distances by paces, he must make a further deduction, whenever he ascends a hill; because they will then become shorter. Pl. 26, fig. 5.—These operations are in some measure necessary when a country is taken up by the eye: otherwise the position of the different objects, and their distances from each other, might be too inaccurate. However, if an Engineer has a very correct idea of distances, he need only find the position of a few villages, and then fill up the remainder by his own judgment.

§ 612. WE will further suppose, that an Engineer is ordered to make a plan of the country, within and near the villages A, D, B, C, in Pl. 31, fig. 3, which are in sight of each other; and that he must ascertain their exact position, without the possibility

fibility of being able to measure the length of any side.

In that case he must take the angles $A B D$ and $B A D$ for his main triangle, and afterwards the angles $A C D$ and $D C B$, and sketch in every part of the country between or near them. — At his return he will take a fresh piece of paper, and, having drawn a line upon it of a convenient length; he must mark two points, as at a and b , in fig. 4, to represent the villages A and B , in fig. 3. He must lay down their angles with a protractor, and draw the sides $a d$ and $b d$; that their intersection may show where he is to place the point d . And he must then carry the angle $A C D$ (or n) within his main triangle from the point b , and $B C D$ (or m) from the point a ; as represented in fig. 4, by M, N . — The lines which are drawn through these points will meet at E . Consequently, if he passes a line from d through E ; lays down the angle v at v , and t at T ; and draws two fresh lines through them from b and a ,

they will cut each other at *c*, and mark the position of that village.—If he can afterwards learn the distance between any of these places, he may divide it into a scale and add it to the plan.—By the same means he can find the position of as many objects as he pleases, and correct a map; in case a village, or any thing of consequence, should have been left out: provided it is visible from two other points.

If I am reconnoitering a town or fortress, of which I have a correct plan, and wish to mark the place where I am standing at any particular time, it will only be necessary for me to take one angle.—For instance: let *c*, in Pl. 31, fig. 5, be my position; *A*, *D* the face of a bastion, or any two objects in a line with me; and *M* the angle taken.—Consequently, if I lengthen the line *ad* upon my plan (fig. 6.), fix the point *x* wherever I please, lay down an angle at that point equal to *AMB*, and draw the line *cb* parallel to *xx*; I shall have the point required.—By the same means

Of taking up Ground entirely by the Eye. 201

means I can also mark the position of a battery upon my plan, as shown by fig. 1 and 2, in Pl. 32.

C H A P T E R IV.

Of taking up Ground entirely by the Eye.

§ 613. **T**HIS is not to be done with accuracy but by those who have an experienced eye; and even then I am of opinion that their plans will seldom be very correct or useful.—However, it frequently happens, in military operations, that no other method is practicable.

§ 614. As soon as an Engineer has made his sketch from a map, he must ride out to compare it with the country; and if, upon examination, he should find it to be imperfect, he may proceed in the following manner:

Let the 29th Plan represent the country, and *f*, the first stand he has made. At
that

that height he will observe that f , g , and the village d , are in a straight line: consequently, he can place them upon paper, and draw a dotted line between them, to guide his representation of the ground.—He will then find that f , c , and e form another alignment; which he may also draw in his sketch by guess.—Or, if he should be unwilling to trust entirely to his eye in laying down the angle, a very simple expedient will enable him to find it with tolerable accuracy; viz.—Let him set up a stick or picket at f , and another at b , in a direct line with the steeple of the church c ; and having tied a string to f , describe a circle round the summit of the hill: then draw the line fi at right angles with fb , and divide the space between them into *two, three, four*, or more equal parts, till one of them falls into the alignment f, g, d . By these means he may take the angles afg , afb , and those of every other visible object.

When he has drawn as much of the ground as he can discover from f , he will
make

make a second stand upon the hill *g*, and proceed in the same manner till his sketch is completed.

§ 615. OR, if he covers a common trencher, or any circular piece of wood with white paper, and marks degrees or divisions upon it, as shown by fig. 7. Pl. 31: he will have an instrument with which the angles may be taken with greater nicety. And if he afterwards makes use of it as a protractor, it is of no consequence into what number of degrees the surface may be divided. Because, if an angle is found to contain *thirteen* of those divisions, when in reality it may have *thirty-five*, or any other number of degrees, and the same *thirteen* divisions are laid upon the plan; the angle must be correct.—For the convenience of the person who takes the angles, it may be raised a little above the ground: and if he retires a few paces, and carries his eye gradually from the point which marks the centre of the board to the object before him; he will see at once
by

by what line it is cut, and perhaps with more accuracy than if he was to stand close to his instrument.

CHAPTER V.

Of taking up Ground with a Compass and another Instrument.

§ 616. **A**S it frequently happens, in military operations, that a large encampment or position is to be taken up in the course of half a day, and that the Engineer who is employed dare not dismount his horse: I cannot recommend the entire use of a compass. But, as it is at the same time a very serviceable instrument in forests and enclosed countries, where alignements are not to be taken, I shall endeavour to give a sufficient explanation of its use, and in as few words as possible.

If I make *e*, in Pl. 29, my first position, I must draw a line cross my paper to represent the north and south, and place my
compass

compass upon it; and when I find that the needle stands exactly over the line, I may take the bearings of as many objects as I please. I must then measure the length of my base $e l$, as well as of all those lines which I suppose will not be again visible, and make a second stand at l .—Here I take the bearings as before, and the intersection of some of these lines will make it unnecessary for me to measure them upon the ground.

In taking up roads, ravines, or rivers, a compass is also of great use.—For instance; if I wish to make a section of fig. 4. Pl. 26, and of the country near the river, I make 1 my first position, take the bearings of the objects on each side, and measure the line 1, 2. At 2, I take the bearings as before, and measure on to 3, &c. till the whole is completed.

§ 617. If I am desirous of working with great accuracy, my sketch book may be prepared for the purpose in the following manner.—At one end, its cover must pro-

ject so far beyond the leaves, that a compass can be screwed upon it, without interfering with the paper on which the sketch is to be drawn. The leaves must then be divided into equal squares, and each side of those squares supposed to be *one, two, three, or four hundred paces* in length; whichever may be most convenient.

When I come upon the ground, and have determined on the point where I intend to begin, I must keep turning my book, till I find the needle has fixed itself, and exactly corresponds with the north and south line upon the sketch; before I can either mark the position of any objects, or measure their distances.—The supposed size of the squares will be a sufficient guide to me in expressing the length of each line: but it must be remembered at the same time, that, whenever they pass diagonally over them, a proportionable deduction will be necessary; because the diagonal of every square is to its side, as *seven* are to *five*.

§ 618. As it very rarely happens in the field, that ground can be regularly taken up with an instrument; I shall confine myself to a description of one only; which may be prepared and used with great ease. It is a species of astrolabe, with which the angles can be taken by means of a common ruler, without the assistance of dioptrical sights*.—It is made of wood, and on one side its circumference is divided into 360° .—It has a cavity to receive a needle; which is cut in such a manner, that when the needle has fixed itself, it remains parallel to the diameter of the board, between 180° and 360° : consequently this diameter is the real line of magnetic meridian. — To mark the angles on paper, nothing more than a common plain table and ruler are requisite: but they must be prepared in the following manner:—Upon a rectangular board you must describe a

* The ends *d e* represent two upright pieces of wood, which are used instead of dioptrical sights. If you look at an object from *d*, the line of sight will pass the centre *c*, and the opposite side *e*.—These ends ought to have been drawn in perspective.

Translator.

circle, divide it into 360° , and let a moveable ruler be screwed on its centre.—One side of this board must also be parallel to the diameter between 180° and 360° .

As soon as I have taken an angle I must turn my ruler to the same point on this circle, fix it with the screw, and lay it close to the plain table, as shown by fig. 3 and 4.—By these means I can represent any angle, and give my lines their proper length*.

That side of the board which is laid against the plain table is parallel to the diameter A B, or 180° , 360° , and to the real line of magnetic direction on the large instrument.—Consequently, any line drawn parallel to A B on the plain table, must represent the real line of magnetic direction.

* An experienced eye will never stand in need of such assistance; and when an instrument is to be used, I think it can scarce ever happen that an officer should not have it in his power to substitute a better.—*Translator*.

C H A P T E R VI.

Of taking up Ground by Paces.

§ 619. **W**HEN Engineers allow their guides to pace the distances, it is highly probable that their plans will be incorrect. Therefore, if they cannot measure the whole on foot, they may procure steady horses, and abide by their paces: for they are always more even than those of men. But, as some make longer paces than others, it is of course necessary that every officer should know how many his own horse will take in a mile; and if any of them should be obliged to ride a second, before the work is completed, another scale must be added, and divided according to the length of his steps.—To avoid the possibility of a mistake, I would also recommend it to them to mark off each hundred in succession.

The Russians generally measure the length of each day's journey, while their troops are on the march.

CHAPTER VII.

Of taking up a Camp or Position.

§ 620. **N**OTWITHSTANDING it may sometimes happen, in consequence of the badness of the roads, or of the length of the march, that the last regiments cannot join the encampment before noon : a plan of it should be made in the course of that day ; or at all events, of the most material parts of it.—And if the army is not ordered to march the next morning, the survey must be completed.

§ 621. IF two Engineers are employed together, they must share the business between them ; that is to say, one may take the right, the other the left wing, or one may take the front, and the other the rear line, &c.—And they must then settle with each other where their respective sketches shall meet.—For instance ; if they have agreed to join them at the road *a, c, f,*
Pl. 29,

Pl. 29, which passes through the centre of the encampment ; they will both measure its length at the same time (each reckoning by his own scale and paces) ; and, when they have sketched in the ground on each side, they will separate and take up the remainder of the position.

§ 622. WHEN the encampment itself is taken up, it is usual to begin at a flank, and to proceed along the front : marking each regiment in succession, and making off-sets to every important object. In a retrenched camp the Engineers can either begin with the works, or draw them as they go down the line. — In either case their angles, batteries, cannon, palisades, &c. must be represented with the utmost accuracy ; as well as their distance from the tents, and the nature of the ground on all sides.—Whenever an army is formed into two or more lines, it is of course necessary that the front of each should be surveyed with equal attention ; and if the Engineers are previously acquainted with

the strength of the regiments, they can at once ascertain the extent of ground they will occupy, and the length of their respective intervals, without measurement.

§ 623. WHENEVER a road happens to pass along the line of encampment, as in the 29th plan; it may be used as a main or base line: in which case its length, direction, and windings must be accurately described.

§ 624. AN Engineer ought never to undertake the survey of a camp or position without a guide; and he must take care to express all the objects which are near the roads. Because a cross, a guide-post, or a single tree will assist him in his work, as well as the Commanding Officer in the distribution of his posts and detachments.

C H A P T E R VIII.

Of taking up Rivers and intersected Ground.

§ 625. **T**HE windings of all rivers and rivulets must be correctly represented; as well as their shoals, islands, fords, bridges, and banks: for these are things of very great consequence in military operations.—Their names ought never to be omitted; and the course of the smallest stream should be marked by an arrow.—But as there are also several circumstances worthy of notice, which the most perfect plan cannot comprehend, the Engineers will be obliged to add a written description of them, for the information of the Commanding Officer.

This written account will show whether the rivers are liable to sudden floods or not, whether their bottoms are good or bad, if they are fordable, of what materials the roads are made, whether they

are in a good or bad state, what is to be discovered from the heights, &c.

§ 626. I SHALL now describe three of the most common methods of finding the breadth of a river, and I think they will be sufficient for my purpose.—The first is shown in Pl. 26, fig. 4; and its operation is as follows:

Let the point *a* be marked by a picket; and measure six toises in a straight line towards a tree or any given object, on the opposite side of the water, for the point *b*.—Then form a right angle *b a d*, extend the line *a d* as far as you please, and mark the point *g* at the end of it.—Let *e* divide the line *a g* into two equal parts, form the right angle *f g b*, and lengthen the lines *c e* and *g b* till they intersect each other.—Consequently *g i* will be equal to *a c*, and if you subtract *a k* you will have the exact breadth of the river.

The same means will enable you to ascertain the distance of an enemy's battery or fortrefs.

§ 627. SECONDLY, you may place yourself at the edge of one bank, and lower one corner of your hat till you find it cuts the other ; then turn gently round, and observe where your eye meets the ground. —Your distance from that point will be nearly equal to the breadth of the river.

§ 628. THIRDLY, take two pickets of different lengths, drive the shortest into the ground close to the edge of the bank, measure some paces back from it, and drive in the other till you find by looking over both that your sight cuts the opposite side. Then pull up the first picket, measure the same distance from the second, in any direction that may be most convenient, and drive it as deep into the ground as before.—Consequently, if you look over them again, and observe where the line of sight falls, you will have the distance required.

§ 629. WHEN a rivulet passes through a thick copse, and divides itself into several branches, as is frequently the case ;

particular attention will be necessary on the part of the Engineer. For, instead of representing the mere shape and extent of the thicket, with the supposed course of the rivulet, he must follow all its branches; and endeavour, by means of frequent offsets, to make his survey as perfect as circumstances may require.

The brush-wood must be properly expressed in his plan, as well as the bridges, and all those parts which are either boggy or likely to become so after rain.

Such information will be expected, and may be of the greatest importance during an action, a retreat, or a march.

CHAPTER IX.

Of taking up Woods.

§ 630. **I**N such employment an Engineer will find his compass of particular use; because it in great measure supplies the want of triangles or alignements.

But,

But, as I have already explained the use of that instrument in the fifth chapter, I shall only endeavour to lay down a few rules, which will be of use to him in working by the eye.

§ 631. HE must first ride round the wood, or as much of it as will be comprehended in his plan; and when he has measured the length of each side, he will lay them down with their proper angles, as shown by *f, t, u, v, w*, and *x* in the 29th plan.—Whenever a conspicuous or a remarkable object happens to be in a line with any of the sides, he will mark it upon his sketch; and if he wishes his plan to be very exact, he may make off-sets to the hedge or boundary of the wood whenever it leaves his main lines. In general, however, he may draw them and all the debouchés by the eye.

§ 632. When this is done, he must take his guide into the wood, and measure the roads which pass through it: for he
will

will then divide it into small figures, and be able to find its extent with accuracy.

§ 633. His plan must show the nature and thickness of the wood, as well as the bridges, ponds, swamps, and openings within it; and in some cases it is even necessary to mark the foot-paths, especially when it lies between us and the enemy; that the General may be able to make a proper arrangement in the distribution of his posts, or in case he should have occasion to march through it.

CHAPTER X.

Of taking up Ground in a hilly Country.

§ 634. **T**HIS is one of the important parts of the duty of an Engineer, which depends more upon practice than established rules.—For, unless he has frequently exercised himself in measuring heights, and in making their profiles; as shown by fig. 5, Pl. 26, and fig. 5, Pl. 30; he

will frequently err in his supposition of their height and slope.—And if his measurements should be accurate, he must be equally careful in expressing them upon paper: otherwise his labour will have been thrown away.

§ 635. WHEN many hills stand near or above each other, they must be examined with attention on all sides, as well as from their summits. For it is of great consequence that the particular height of each, its declivity, its shape, and the nature of the soil, should be correctly ascertained.

The ravines and their banks must be taken up according to the rules which have been prescribed for the survey of a river, and a correct description must be given of all the roads which pass through or cross them.

CHAPTER XI.

Of taking up Towns and Villages.

§ 636. **I**N taking up a town it is usual to begin with the market-place, and to lay down all the adjoining streets with their proper angles.—When this is done, their length and breadth must be found, and an accurate description made of all the remarkable buildings, cross-streets, and alleys.—If there is no market-place, the survey may be begun at any of its longest streets.

When a town is surrounded by a wall, an exact measurement of it ought never to be omitted : especially if it is probable that the place will be afterwards attacked or defended.

§ 637. **I**F it is necessary that a village should be taken up with great accuracy, the same rules are to be observed ; and the difficulty will be in some measure increased

creased by the want of straight lines.—In general, however, it is sufficient if you can ascertain their length, and insert the houses by guess. But in both cases the position of every castle, church, walled churchyard, garden-wall, &c. will be of the greatest consequence.

CHAPTER XII.

To make a Plan of an Action.

§ 638. **I**N this instance a previous knowledge of the ground is of all things the most essential: because it will be impossible, during the action, to enter into an examination of it; on account of the constant attention which must be given to the different movements of the troops. And even then, much must be left to memory, or to such information as can be procured afterwards by conversing with intelligent officers upon the subject.—Nothing however will tend more to facilitate a comprehension of the affair, than to
begin

begin by representing the exact position of the lines, and of each regiment, as soon as the army is formed in order of battle.—If we remain masters of the field, the plan must be made perfect as soon as the action is over.

§ 639. SUCH a plan cannot be complete, or properly instructive, unless some of the principal and different positions are drawn upon separate pieces of paper, and pasted on the parts to which they belong.—The first positions should be expressed either by dotted lines or a very faint colour, in order that the others may be perfectly distinct*.

§ 640. PERSPECTIVE plans of an action are pleasing to the eye, but they neither convey an idea of the manœuvres which have been performed, nor show how far the Commander in Chief may have followed or deviated from the established rules and principles of the art of war.

* See Vol. II. Plans 4, 5, 6, 7, and 8.—*Author.*

C H A P T E R XIII.

Of taking up Trenches.

§ 641. OFFICERS belonging to the corps of Engineers are always employed in sieges; the approaches are carried on under their direction, and it is their duty to make plans of them whenever they are required.—Consequently, as I am writing solely for the instruction of *Field Engineers*, it will not be necessary for me to dwell long upon the subject of this Chapter.

The plans of trenches are usually made by means of theodolites, plain-tables, and astrolabes; or, in a case of necessity, the compass may be used for such a purpose; and you must then follow the rules which have already been given for taking up ravines, roads, &c.

§ 642. THE breastwork, or rather the earth that is thrown up on the side next

to

to the fortrefs, may be represented by a strong black line; and the other edge of the ditch by a dotted line.—The space between them may be painted brown; or the work of each night represented in different colours, with a marginal reference to explain their meaning.

CHAPTER XIV.

Examples relating to the foregoing Chapters.

§ 643. **A**S these two examples contain all the various parts of which a tract of country can be composed, I have added them with a view of bringing together the whole of what I have hitherto had occasion to point out in the foregoing Chapters. — *First*, I will take up the heights, works, &c. which are represented in fig. 3. Pl. 22, merely by paces, without the help of a compass, and make use of the scale which is annexed to the 28th Plan: supposing it at the same time to have been divided into two thousand man's

man's paces.—The beginning of my survey is optional, but I will here suppose my first stand to be made on the hill *g*, on account of its height. — On this spot I draw in as much of it as I can discover, taking particular notice of the contour of its summit, and of the windings of the road to *m*, which I mark by a dotted line.

Upon another sheet of paper I also make a sketch of the country, with all the roads, valleys, ravines, &c. as far as my eye will carry me, and extend it afterwards so as to take in the more distant objects, when I am upon the other heights : particularly from the hill *i*.—But my greatest attention must be turned towards those which are in the enemy's possession ; because I cannot venture upon them.—And, in this case, I suppose the ground beyond the river to be entirely occupied by them.

In my principal sketch, the whole of the ground will be taken up by paces, after I leave my first position at *g*. Consequently, that which I carry on at the same time by the eye, is only intended to give me

assistance in completing my finished drawing, after I return home.

§ 644. WHEN I have represented the height g , I begin on the right of the retrenchment, lay down the two salient angles by my eye, and find the length of each line in the following manner:—The first line measures 186 paces; but as they will have been shortened on account of the steepness of the ascent on this side, I make a proportionable deduction, and put down only 168. The 2d line measures 144; the 3d, 156; and the 4th, 228 down to the road.—Here the descent may have lengthened my paces, therefore I add 24 to them.—The fall of the ground must be represented with accuracy, and the position of the embrasures marked in each side.—I then measure the road, lay down the salient angle at b , and give the length of each line as before.—When this is done, I mark the reentrant angle, lay down the whole bastion from the summit i , and draw in the road leading from o to n .—

Here

Here also I give an exact representation of the form of the height, and continue my measurement of the parapet with similar attention, till I reach the end of it. I then measure the abbatis as far as the hollow-way, and, having marked its breadth, I proceed to the second abbatis, which is formed on the break of the hill; from thence to the rivulet; from the rivulet I follow the abbatis up the next height, and then measure through the wood to *n*.—The break of the height below *o*, *n*, the nature of its descent, and the length of these abbatis must be drawn with attention. But, as I cannot measure that which is formed in the ravine where the rivulet passes, I must content myself with an examination of it from the heights *o*, *n*, *n*.

§ 645. I HAVE before observed, that the heights beyond the river are supposed to be occupied by the enemy; therefore I now take an escort of light infantry with me, that I may not be disturbed or taken prisoner by his patroles.—I also take pos-

cession of the bridge and ford $a b$; and, for the sake of greater security, I post sentinels upon all those heights which overlook the opposite shore.—These sentinels will receive orders to fire, whenever they see the enemy draw near the river, and at such a signal I shall make an immediate retreat, for the reasons which have already been given in the beginning of this work.

§ 646. WHEN these precautions have been taken, I continue my measurement along the river; endeavouring at the same time to ascertain its breadth, the height of the banks, and the depth of the water. I also mark its ford and bridge, and examine the heights above them, that I may be able to give an exact representation of their ascent, and of the ravines between them.

§ 647. As soon as I find myself in a line with the height n , I measure along the edge of the water to the rivulet; and from thence to the ford: but, between those

two points, I make an off-set to mark the position of the ditch of the traverse *k*.—I then proceed along the hollow-way, draw the felled trees, the heights on both sides, and the flèche *d*, with its proper angle and the length of each face.—From *a*, I continue my measurement till I am opposite the rivulet on the other side; from thence to the end of the ravine, (of which I give an exact representation); and from the ravine to the stone-bridge.—Here I mark the breadth of the bridge and river; and, when that is done, I draw in as much of the country as I can discover from that point, and follow the road up to the flèches at *c*; making a deduction as usual on account of the ascent.—Here also I lay down the angles and faces of both these works, and proceed to *m*: marking the palisades as I go, as well as the real winding of the road.

§ 648. At *e* I draw in as much of the hill as I can discover, and give a correct representation of the work, and of the pa-

palifades *r*.—I then measure the distance from the left of *e* to *m*; and, when I have found the extent of that work, I proceed along the trous-de-loup to the hollow-way, and to the first abbatis at *n*.—Here I draw the fall of the height, and the wood in my front. From thence I return to *m*, measure the distance to the end of the palifades at *l*, and close my sketch.

§ 649. To make my finished drawing, I begin by laying down the river; and, as its course is almost straight, I consider it as a base, and mark the rivulets, ford, and bridge, with the proper intervals between them.—Upon looking over my sketch, I find the distance between the point below *n*, where I began to follow the water, and the last rivulet, to be nearly equal to the line I have drawn from the upper abbatis through the wood: consequently, if I take the same number of paces off my scale, rest one leg of the compass in that point, and carry the other perpendicular [to the river, I shall know where to place the
the

the end of the abbatis.—I then lay down the retrenchment *ib* upon a separate piece of paper with its proper angles, and draw a base or diagonal line from one end to the other, to ascertain its extent. I add this line to the whole length of the abbatis; and, resting one leg of the compass in the point already found, I sweep an arc towards *l*. Of course, if I take the number of paces which have been measured from *b* to *l*, with the necessary deduction on account of the ascent and winding of the road, and sweep another arc from *b*; their intersection will give me the real position of the point *l*, or the right of that work. And, if I have drawn the road *il* with care, and marked the point where it passes between the works in front, I cannot err much in laying them down. Afterwards, I represent the two heights *gi* with their retrenchments; the works *ef*; the position of the different abbatis, flèches, and other objects which may be found in my sketch. I give as accurate a description as possible of the heights beyond the river, together

with a written account of the roads, the depth of the water, &c.—And lastly, I add a scale and compass, that my plan may be complete in every respect, and fit for use.

§ 650. THE *second* example shall be the retrenched camp near Schweidnitz (Pl. 28); which I will take up by horse-paces, without the assistance of a needle.

§ 651. IF another officer is employed at the same time, the work must be equally divided between us. The road from Freyburg to Neumark may then be the line of division, and I will take up the country on the right of it.

In that case, we ride together along the road, and mark the position of every object on the right and left; each calculating by the paces of his own horse, that the parts may be properly joined together at the conclusion of the survey. For instance, we draw the rivulet which runs from Nieder-Arnsdorff, the pond, the road branching off to the right, the *flèches* on the left, the

the high road from Striegau to Schweidnitz, &c. till we arrive at the road leading from Peterwitz to Wurben, where our respective sketches will terminate. We then separate. I ride towards Wurben, and represent that road, the small wood on my right-hand, the different roads to Neudorff, the rivulet, the wooden-bridge, and the Brech-house, with the proper intervals between them, and as much of the ground on each side as I am able.

R E M A R K.

§ 652. IF I was not provided with a map, or if my map was too incorrect to give me the real position of the villages, I should now measure the straight road from Wurben to Jauernig. By which means I should have a triangle which would mark the situation of Wurben in respect to Buntzelwitz, as well as of almost every other object within my division.

§ 653.

§ 653. FROM the Brech-house, I continue my measurement along the road leading from Hoh-Boferitz to Schweidnitz, till I arrive at Roth-Kirchdorff: and, as I observe at the same time, that Wurben, the height above it, and the meadows which are intersected by ponds and rivulets, cannot be taken up on horseback; I proceed on foot as far as N° 69.

§ 654. FROM the summit of the height of Wurben, I take notice of all the churches, large houses, and hills within my sight; and mark the direction of each of those objects by means of a dotted line.—For instance; I draw lines to the churches at Wurben, Peterwitz, and Puschkau, to the large house in Tzfschechen (which line passes the windmill at N° 9, and the corner of a farm-yard at Neudorff); then to the churches at Jauernig, and Buntzelwitz; and lastly, to the large house in Teichenau,

FIRST REMARK.

§ 655. IF, on such occasions, an officer should not be able to judge the angles by his eye, he may make use of the expedient which has been mentioned in the 614th paragraph.

SECOND REMARK.

§ 656. WHEN an alignement gives you the position of any important objects, as is the case with that which passes the windmill at N° 9; you may at the same time examine the line of magnetic direction, if you should happen to be in possession of a compass, and mark their intersection with accuracy, that they may be afterwards expressed in the plan.—The line of magnetic direction may also be taken from a map.

§ 657. WHEN I have given a correct representation of the height of Wurben, as
well

well as of those which lie near it, and observed how far they command each other; I measure the parapets of the different works, and endeavour to ascertain the nature of their defence.—And when I have extended my survey to Buntzelwitz and N° 69; I remount my horse, and take up that village, together with the work 68.—I then return towards Wurben along the road from Jauernig, mark its distance from the end of Buntzelwitz, and express the works on the right and left of it; till I reach the epaulement at N° 6. From thence I proceed to ascertain the position of N° 7, 8, 9, 10, and 11, draw in all those heights, and take as many alignements as possible from the windmill at N° 9.

I then continue my measurement along the road as far as the cross near Wurben, and from thence back to Neudorff; marking the cross-roads and rivulets at the same time. When I have surveyed that village, I return along the road to Buntzelwitz, which gives me the position of some other works, and, if I proceed from thence to Jauernig,

Jauernig, I shall be able to insert N° 66, 65, 64, 62, 61, and 60.

To conclude my sketch, I make an accurate survey of Jauernig, Wickendorff, and Nieder-Arnsdorff.

§ 658. My companion, (who left me on the road leading to Neumark, and not far from Peterwitz) first measures the number of paces to that village, and marks down every object by the way : particularly the different roads near the end of the town. He then makes a survey of the village ; and, when he has ascertained the position of the large pond opposite the castle, he rides along the side of the rivulet to N° 22.

§ 659. FROM N° 22, he proceeds in as straight a line as possible towards the church of Wurben, (passing close to N° 20), till he comes again into the Neumark road. — Here he measures his distance from the trous-de-loup in front of N° 18, and when he has inserted every object between that work and Peterwitz, which

which may have escaped his observation, he returns to N° 22.

§ 660. FROM hence he again continues his measurement in a straight line to the star-fort N° 23, and represents all the objects on his right and left hand. On this height he observes his alignment with the church of Wurben, and finds, upon examination, that it has the same direction as the line he measured from N° 22: consequently it will be afterwards a considerable assistance to him in laying down the exact position of the works in that part of the retrenchment.—Other alignments are also to be taken upon Peterwitz, Puschkau, Tzfschechen, &c.—He then represents the work itself, the height on which it lies, and whatever objects are visible from it.

As this is a regular star-fort, he will only find it necessary to measure its diameter.

§ 661. HE now rides along the road to Puschkau, or, if the country will admit of it,

it, he proceeds in a straight line to the church. Here he makes a survey of Puschkau and of the country between it and Peterwitz: and, when that is completed, he continues his measurement to Tzfschechen, marking all the objects by the way, and takes up that village.

R E M A R K.

§ 662. IF he should not have a correct map of the country, he must either go along the road, or measure a line from Tzfschechen to Peterwitz, and from Peterwitz to Puschkau, for the purpose of ascertaining the exact situation of those three villages, which form a triangle.

From Tzfschechen he returns to N° 23, and represents the country between those two places; and from N° 23, he measures a straight line to N° 26, that it may enable him, together with the line which he has already drawn between N° 22 and 23, to lay down the relative positions of 20 and 23.

A particular measurement of the ground between N° 22 and 26 will not be necessary : for, at N° 23, he will have had an opportunity of examining all on that side of the rivulet, and the remainder may be drawn when he takes up the abbatis and N° 24.

§ 663. HE now surveys N° 26 on foot, paces the abbatis as far as N° 25, and the trous-de-loup to N° 24; from thence he returns to the abbatis, and proceeds to N° 22, 21, 20, 19, 18, 17.—All these works are taken up by the way; and when he has finished his survey of N° 17, he again joins the abbatis at 19, and goes along the other side of the wood, till he reaches the flèche N° 27, and his former station at N° 26.

§ 664. FROM N° 26 he proceeds along the shortest road to Tzfschechen, and from thence in a straight line towards the rivulet of Freyburg, till he arrives at the road leading from Striegau to Schweidnitz.—Here he takes up the village of Zedlitz, and
the

the rivulet of Freyburg as far as the end of the town, crosses the road again near N° 39, returns behind the village, surveys the heights, the works 36, 37, 35, 34, 33, and 32, the road in front of N° 38 and 28, and both those works. — Afterwards he draws by his eye all the low ground between 28, the abbatis, and the road to Neu-mark : and ascertains the position of the redout N° 16 by making an off-set either from that road, or the corner of the abbatis.

§ 665. WHEN this part of the business is finished, he returns towards Zedlitz by the road which crosses the highway above N° 61, surveys the country on each side till he reaches N° 29, and then takes up N° 30, 31, 39, 41, and 42. — From N° 42 he goes back to N° 39, where he left the road to Striegau. — He then follows the great road towards Striegau, till he arrives at the place where it is crossed by that of Freyburg ; expressing the ground on his left at the same

time, to complete that part of the sketch:— On his right, however, he need only draw as much as is visible from the road.— From this point he proceeds to survey the works N^{os} 61, 58, 57, and the Farben-Hohe, and takes alignements upon all the conspicuous objects in his view. Here he observes that the large house in Tzfschechen and the church at Jauernig are in a line with his station, as well as the church of Wurben and the Busch-Muhle.— Afterwards he measures the several works which are joined together by palisades from 56 to the trous-de-loup in front of N^o 42, and again closes his sketch at the end of the village of Zedlitz. And lastly, he takes up the wood of Zedlitz, the rivulet of Freyburg, the brook which runs into it from Nieder-Arnfdorff, and concludes at our first station on the high road leading from Freyburg to Neumark.

R E M A R K.

§ 666. THE work of each day ought to be taken out of the sketch book, before the survey is begun on the succeeding morning : otherwise many circumstances may be omitted, which would have added to the fulness and accuracy of the plan. Or, if two officers can go together, one of them should make the finished drawing, while the other is employed in taking up the ground.—If there is any uncertainty in the movements of the army, the sketches should be as complete as possible : and the Engineers must be at work every day ; because it is highly improbable that they will have any opportunity of correcting their errors, or of seeing the same ground, after it has once been left.

§ 667. IF I can take the outlines of my sketch from a map, I must draw the needle, enlarge the scale, and mark the position of all the churches, castles, &c. as I find them.

When I arrive upon the ground, I must add another scale of my own, or my horse's paces, and prove the map by the measurement of triangles; as between Neudorff, Wurben, and Bunzelwitz.—If I find it to be accurate, my labour will be greatly facilitated.

§ 668. WHEN I lay down my part of the country, I first take the roads which are tolerably straight, as bases, then draw the rivulets, afterwards the villages, and lastly the hills, ravines, &c.; guided at the same time by the alignements which I have taken upon the different heights.—My companion begins by marking the position of Peterwitz, Puschkau, and Tzschechen; considering the line between the two latter villages as the base of a triangle, which, when taken in his compasses, ascertains the situation of N° 23. From 23, he carries a dotted line to the church of Wurben, which gives him the front of the retrenchment from N° 22 to 18.—A line drawn between Tzschechen and N° 23 is

is also the base of a triangle, which marks the position of N° 26.—Of course the wood of Tzschuchen and its abbatis may be easily expressed.—And thus we continue our joint operations till the plan is completed.

§ 669. WHAT has already been said in this chapter will be sufficiently instructive to those young officers, who are unacquainted with this part of the military profession; provided they pay a proper attention to the rules which I have given them, and complete their drawings regularly every evening, or before they resume their work in the field on the succeeding morning.—At first they may meet with difficulties, but those difficulties will soon be diminished by steady perseverance, and in the course of practice they will have the satisfaction to find they can proceed without the least hesitation.

CHAPTER XV.

Of Plans in General.

§ 670. **A**CCURACY ought to be the principal object of our attention in all military drawings, and whenever an error has been committed, it must be immediately cut out or corrected; otherwise it may mislead the General, and involve the army in the greatest difficulties.—They must express the exact form and declivity of every height, as well as the approaches to them; that it may at once be known how far they command each other, and whether they are difficult or easy of access:—they must point out all advantages and disadvantages of situation, and the best positions for the different posts and guards:—and lastly, they must show the ways in which the position will be capable of being occupied or attacked.—These points are only to be attained by practice and assiduity, but without them a
plan

plan would scarce be of more use than a common map.

§ 671. It results from what has been said, that the finished drawing ought always to be made or superintended by those who have taken the first sketch of the ground. —And, if there are any parts of the country which cannot be properly represented on account of the smallness of the scale, or if certain points are to be expressed by marks, a written explanation of them ought to be added in the field; lest they should be afterwards productive of confusion, or perhaps altogether omitted.

§ 672. If an officer is entrusted with this employment who cannot draw well, or if he is obliged to be very expeditious, his plan ought to be as clean as possible; the words, references, &c. must be uniformly and distinctly written; and whenever he uses colours, he must take care that they are properly prepared.

§ 673. I HAVE frequently observed that the Field-Engineers draw their plans of a whole campaign in the same form ; probably with a view of satisfying the taste, or rather the caprice of their employers. But this is a very great error ; for, to effect their purpose, they are obliged to make use of different scales, and by the constant reduction and enlargement of them, which is not to be avoided, they are apt to commit mistakes, and sometimes they even render their drawings unserviceable. If a tract of country is contained in several plans, and formed upon the same scale, they may be laid together whenever you wish to examine them, and, as there will then be a greater probability of their accuracy, upon what ground is an uniformity of shape to be recommended ?

§ 674. IF you wish to copy a well-drawn plan, and stretch your paper upon a board after the outlines have been traced in pencil, you also commit a fault ; because it will contract and expand itself in different places,

places, when wetted, and of course produce errors which did not exist in the original : especially if the scale is small, and if the ground has been taken up with an instrument.—The same circumstance may be observed when a finished plan is put upon linen.

§ 675. It is by no means my intention to lay down the fundamental rules of plan-drawing, neither would the limits of this treatise allow me to enter into so extensive a field ; I only wish to offer instruction to those officers who have some idea of the business, and to give such hints as will tend to improve them in it, or assist them in the exact representation of the different objects which they must necessarily meet with in the course of every survey*.

* The last paragraph of this chapter is an exact repetition of § 673, therefore I have omitted it in the Translation.

Translator.

CHAPTER XVI.

Of Water and Morafs.

§ 676. UNDER these heads may be ranked (*a*) springs; (*b*) brooks; (*c*) ditches; (*d*) canals; (*e*) rivers; (*f*) large rivers; (*g*) lakes; (*h*) ponds; (*i*) holes or pits; (*k*) morasses; (*l*) fwamps; (*m*) bogs; and (*n*) unfound earth.—All of which must be accurately and properly expreffed in every military plan.

§ 677. (*a*). SPRINGS generally form brooks or streams; fometimes however they run into the ground, and, in that cafe, they occafion bogs, which are very dangerous to the cavalry: particularly when they are fcarce vifible.—Their pofition ought alfo to be marked, on account of their utility in a place of encampment.

§ 678. (*b*). BROOKS are to be represented by a fingle line, according to their courfe,

†

and

and not of the same thickness from one end to the other.—If they are to be coloured, a streak of pale ink, inclining rather to a blue than green, ought to be added on the lower or right-hand side, to express the shade of the black lines *.—Let them be ever so small, their names should not be omitted, especially when they run down from heights; on account of their capability of being suddenly swelled by rain. And if their banks are high, they ought also to be marked in the plan.

§ 679. (c). DITCHES are sometimes of the greatest importance in the course of an action: consequently, their size and position must be carefully expressed.

(d). Canals are to be represented by two straight lines, parallel to each other: and if they are walled on each side, those lines should be red.

* Liquid verdigrise may be used for this purpose. And with a small addition of yellow it makes a beautiful green.

Translator.

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§ 679. (c). DITCHES are fometimes of the greateft importance in the courfe of an action: confequently, their fize and pofition muft be carefully expreffed.

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* Liquid verdigrife may be ufed for this purpofe. And with a fmall addition of yellow it makes a beautiful green.

Translator.

§ 680. (e). A RIVER is to be expressed by two lines, provided the scale is large enough to admit of it, and that which is next the light ought to be thicker than the other.—If the plan is to be coloured, there must also be a strong shade of water-blue, which may be washed off gradually till it is scarce visible on the lower or right-hand side; and, if it is to be entirely black, a pale ink may be used in the same manner.—Much attention will be necessary in representing its breadth and the height of its banks; particularly when a drawing is to be enlarged or reduced: for, on those occasions, errors may be easily committed.

§ 681. (f). A LARGE river* must be drawn by the scale which is annexed to the plan, and an exact representation given of its windings, banks, islands, and shoals.

* This is to be understood as a literal translation of the original word *Strohm*, which, in the German language, implies a large river emptying itself into the sea.—*Translator*.

If your plan is to be entirely finished with a pen, it may be shaded as a large piece of water; or if colours are used, they must be still paler than in the foregoing instance. — Its course must also be shown by an arrow.

§ 682. (*g*). LAKES ought to be drawn with waves, especially when they are very large: but, as this is attended with some difficulty to the inexperienced, they may be washed over with a pale ink or water-colour; according to the rules which have already been given for the representation of rivers.

§ 683. (*b*). IN ponds the water may be expressed by thin lines, if the plan is to be finished with the pen; otherwise it must be coloured as above.

(*i*) Holes or pits are to be represented in the same manner, whenever they contain water.

§ 684.

§ 684. (*k*). MORASSES are generally large and impaffable.

(*l*) A fwamp is a small morafs, and will be ufually found in low ground, where the water is confined.—Whenever a fwamp croffes a road, as is frequently the cafe in woods, it is extremely difadvantageous.

(*m*) Bogs come under the fame defcription, and are often to be met with upon the higheft ground.—Swamps and bogs are to be drawn as moraffes; and it is of great confequence that their extent fhould be fhown in the plan.

(*n*) Unfound earth is gravelly, and has the appearance of being dry.—But, as it is a very great impediment to the march of artillery and baggage, it ought to be properly marked, and the Engineer who leads a column muft always take care to avoid it.

k, l, m, and n might have been brought under the fame head; but, in compliance with the arrangement of the original chapter, I thought it incumbent upon me to tranflate them in the fame order: notwithstanding they are nearly fynonymous in the Englifh.—The fame obfervation may extend to *e, f* and *b, i* with equal propriety.—*Translator.*

CHAP.

CHAPTER XVII.

Of Heights.

§ 685. PARTICULAR attention will be required both in taking up heights, and in the mode of representing them in your plan. First, that it may be at once known, whether your batteries can have an entire command over their declivities, or whether there are breaks which can shelter the enemy from your fire:—Secondly, that you may see how far they command each other:—and lastly, that you may know whether they consist of rock, earth, or sand.

§ 686. IF an officer has not had much experience in this particular, I would advise him to make the profiles of the heights after he has surveyed them, and to lay down others after he has taken them in profile *.

* The necessary rules may be found in the first Volume of my "ACCOUNT of the WAR," Sect. 2.—*Author.*

§ 687. HEIGHTS may be represented in different ways, and, as they ought to be known to every Field Engineer, I shall endeavour to point out the merits and imperfections of each.—The most easy and expeditious manner is merely to shade them with a pale Indian ink; but they will never look well when finished, errors will be frequently committed, and it will scarce be possible to discern how they command each other.

§ 688. SECONDLY, you may fill a hair-pencil with Indian ink, lay a fine ivory comb upon your paper, and draw the lines through it.—Every stroke will then be distinct, and with practice such a drawing may be very highly finished; but, unless you are extremely careful, you will find a difficulty in giving the heights their true slope.

§ 689. THE third is with a pen.—Here the operation is slow; but, on account of its accuracy, and the ease with which it enables

enables you to represent the smallest breaks, I prefer it to either of the other methods. — Some officers begin by marking the shade of the heights with a pale ink, which tends very much to destroy the exact representation of their form and ascent.

§ 690. IN coloured plans the hills are usually shaded with a mixture of Indian ink and carmine, and afterwards washed over with a very pale green.—They are entirely finished with the pencil, and require much time.

CHAPTER XVIII.

Of Arable Land, Meadows, Trees, Gardens, Vineyards, and Woods.

§ 691. **A**RABLE land may be drawn either with the pen or pencil.—In the first case, the balks are usually marked by double lines, and the furrows by single dotted lines, parallel to each other: sometimes they are also washed

over with a faint gamboge or brown.—In the second instance they may be coloured either with a pale mixture of Indian ink and carmine, or a yellow; and the furrows represented by streaks of black, dark-brown, or green.

§ 692. WHEN the pen is used in drawing meadows, three or four dots are placed together to represent tufts of grass; and when coloured, they are first washed over with a very pale black or green, and the tufts of grass are marked either by a darker shade of the same colours or a bright yellow. In both these cases the meadows must be properly distinguished from morafs or marshy ground.

§ 693. TREES may be drawn in different ways, but they must always be in proportion to your scale.—Sometimes they are coloured with a bright green after the outlines have been marked out, and sometimes the shade is only expressed by a deeper colour without any outlines.

§ 694. Woods may be represented by a covering of pale Indian ink, and the trees afterwards made out with a pen. Here however it is of great consequence, that the plan should show whether they are filled with brushwood, or whether the distance between the trees will allow your troops to march through them without interruption.

§ 695. Vineyards are usually marked by small dots, and the stakes are afterwards drawn with a shade to the right-hand.—But in coloured plans, the ground is first covered with a pale yellow, and the stakes are green.

§ 696. In the representation of a garden the ground may be shaded with a pale Indian ink, and the walks suffered to remain white, except when colours are to be used.—In that case, the walks should be shown by a pale yellow, the trees and hedges by different shades of green, and the beds or quarters by a dark brown. Orchards are

to be drawn as meadows, with the addition of trees.

Walls are generally shown by a strong red line, and pales by a faint black or a yellow.

CHAPTER XIX.

Of Roads, Bridges, Fords, &c.

§ 697. **A**LL roads ought to be properly distinguished in a military plan.—Highways are represented by two parallel lines; in smaller roads, one of those lines must be dotted; cart-ways are expressed by one line; and foot-paths by a dotted line.—Sometimes these are afterwards coloured with a pale black or brown.

Hollow-ways must be particularly marked, especially when water runs through them.

Your plan must also show the situation of every ford or ferry, and in the representation of bridges it must explain their length,

length, the materials with which they are built, and the number of their arches.— And, whenever you meet with a bridge of boats, equal care must be taken in marking its pontoons.

C H A P T E R XX.

Of Houses, Villages, Towns, and Fortresses.

§ 698. **H**OUSES may be shaded with the pen, or in coloured plans with a bright red. In the latter case, there ought also to be a stronger shade of carmine or vermilion on the lower and right-hand sides, provided the size of the scale will admit of it.— Churches and large buildings are to be distinguished by a darker colour.

When towns are comprehended in the plan, it is usual to represent the roofs of the houses, and to add a shade on the lower or right-hand side of every line,

which does not immediately face the light.

§ 699. IF colours are not to be used in finishing the works of a fortrefs, the rampart must remain white, the dry ditches will be dotted, and in wet ditches, the water must be drawn as in a pond or river.— If the walls are very broad, they should be marked by a double line, and the spaces between them filled by smaller lines parallel to those which mark their angles.— But as this is a very tedious method, the glacis is sometimes washed over with a very pale black, to relieve it from the paper, and the parapet with a stronger shade of the same colour.

§ 700. WHEN colours are used; the glacis, parapet, and angles are shaded as before with a faint ground of Indian ink or with a green; the scarp, the counter-scarp, the interior talus of the parapet, and the slope of the banquettes, are green; the ramparts yellow; the berm and the
top

top of the banquettes remain white; dry ditches are brown; and wet ditches are shaded with the usual water-green. — All bridges and wood-work must be yellow; and the outlines of the walls, red. — In very large plans the stones are sometimes marked before they are coloured.

CHAPTER XXI.

Of Camps and Retrenchments.

§ 701. **W**HETHER you intend to mark the place where troops have been encamped, or during a manœuvre, the outlines ought to be dotted. — In both cases, the divisions are represented in the same manner and in proportion to the scale; but in the former, a greater depth is given to them than in the latter. — If all the battalions and squadrons are to be shown in their proper colours, the front of each ought to correspond with the uniform, and to be marked at the same time by a thick line; the lines which pass

through them may be white or yellow to represent the buttons, and the rear divisions may show the facings or cuffs.—But when the particular colour of the uniforms is not to be expressed, the infantry are generally represented by white and red; the heavy cavalry by white and yellow; the light cavalry by a pale blue or green; the croats and free-corps by a deep green; the artillery-men by red and black; and the park either by grey and black, or yellow and black.—Or, if this rule is not strictly followed, a marginal reference can at any time explain the meaning of each colour, although the troops of several powers may be contained in the same sheet.

In the Russian service, all the regiments of infantry are dressed in green with scarlet waistcoats and cuffs, and the cavalry in blue with scarlet cuffs: the Cuirassiers have scarlet, and the Dragoons straw-coloured waistcoats.—The Artillery and Engineers have red uniforms with black cuffs and straw-coloured waistcoats; the
former

former with gold and the latter with silver lace.—The regiments of Hussars are in different colours, and the Cossacks have no established uniform. — In the representation of a Prussian Army, the Infantry may be blue, or blue and yellow; the Cavalry white and yellow, or white and red; the Dragoons and Hussars light blue, and the Free-battalions may be shown either by two shades of blue, or blue and black.

§ 702. THE batteries are usually washed over with a very pale black, and the parapets with a stronger shade of the same colour. — The ditches are expressed by a brown, the embrasures by a deep black, and the lines of fire by a deep red.—The abbatis ought to be green; the fougasses, black; the palisades, fraises, and chevaux-de-frise, yellow; and the trous-de-loup, brown.

CHAPTER XXII.

Of colouring Plans.

§ 703. **A**N ill-drawn plan may be relieved by colours, but if it has been well and correctly finished it cannot stand in need of such assistance.— Sometimes an Engineer may be obliged to colour his plans to satisfy the taste of his employer, I shall therefore lay down a few rules for his information.

§ 704. **W**ITH good Indian ink a plan may be completely drawn and shaded before it is coloured ; but if it is of a bad quality, the shades and outlines must not be added till the colours have been laid on : especially if you make use of carmine and gamboge.

§ 705. **I**N representing a large piece of water, the colour must be very faint, except at the edges ; small rivers and brooks may have

have a stronger shade, to make them the more conspicuous.

§ 706. IN a military plan it can never be necessary to colour more than the water, houses, and troops ; or at most, the roads and works ought only to be included.— A painted star or needle, to show the different points of the compass, may be also rejected as an useless bawble.

§ 707. WHEN several districts are contained in a large plan or map ; each of them may be washed over with a faint and different colour, as soon as the pencilled outlines have been drawn, and before any part is made out with ink.—Their boundaries may be also shown by a deep shade of the same colours.

CHAPTER XXIII.

Of ornamenting and finishing a Plan.

§ 708. **T**HE title and scale may be contained within a coloured and shaded ornament, representing a card or a torn piece of paper ; or they may be embellished with festoons of flowers, shell-work, and arms.—This latter method is frequently used by the French : but unless the different parts are in proportion to each other, and properly finished, the plan can never look well.—Sometimes the ornament is also intended to show the particular produce of the country, or the result of an action.

§ 709. THE names within the plan ought to be written in a plain and neat manner, otherwise it will be greatly disfigured ; and whenever the words are likely to be crowded together, single letters may be added,

added, and their meaning explained on the margin *.

CHAPTER XXIV.

Of the Preparation of transparent Paper.

§ 710. **S**TRETCH a sheet of good drawing paper, over a charcoal fire, and sprinkle it with pure white wax; then lay it between two sheets of blotting paper, and keep rubbing them with an iron till all the wax is absorbed.—As soon as it is perfectly transparent, wash it with warm water and a sponge, and it will be fit for use. Or you may use line-feed, or turpentine oil, instead of wax.—In that case, however, it will be necessary to renew the sheets of blotting paper, otherwise the oil will not be entirely dried up; and your paper will

* These lines contain the entire substance of the twenty-fourth chapter of the original work, which I have found it expedient to reduce into one paragraph.—The twenty-fifth chapter is also omitted for the reasons already given in my Preface.

Translator.

retain

retain a very disagreeable smell till it has been some time exposed to the air.

C H A P T E R XXV.

Of copying Plans.

§ 7II. **T**HE quickest method is to trace all the outlines upon transparent paper, and afterwards to fill up the drawing by the eye.—This expedient is frequently used in the field, when you have not time to lay down your sketch in the usual manner, or when you wish to copy a plan which has been pasted upon wood or linen.

Secondly, you may lay a ground of white or red lead upon a sheet of paper, before you fix the drawing upon it, and then trace out all the lines with a pointed instrument.—This will give you an exact impression of the original, which may be afterwards made out or coloured.

Or thirdly ; you may divide the original plan and your paper into squares of equal dimen-

dimensions, and mark each of them with a letter or figure to avoid mistakes.—This latter method will be equally useful in enlarging or diminishing a plan. For instance, if you wish to reduce your drawing to a quarter of the size of the plan, the squares on your paper must be equal to a fourth of those on the original: and if it is to be increased in the same proportion, they must be four times as large.

§ 712. THE French make use of an instrument for these purposes, which they call a *Pantographe* or *Singe*.—It is well known to all mathematical instrument makers, and a description of it may be found in the “*METHODE de lever les PLANS, et les CARTES de terre et de mer, par M. OZAMAN* *.

* See also the *DICTIONNAIRE de MATHEMATIQUE par M. SAVERIEN*.—*Translator*.

CHAPTER XXVI.

To make Glue.

§ 713. **P**UT shreds of isinglass into an earthen vessel, pour a little water upon them, and let them be soaked for three days; then boil them over a slow fire till the smell is gone off, and till they have formed themselves into a glutinous substance.—An inferior sort may also be made in the same manner with parchment; provided the shreds are boiled for six or eight hours, and the water afterwards strained through a cloth.—In both cases the glue must be cut into the shape you wish, before it becomes dry or cold.

CHAPTER XXVII.

To paste Plans upon Linen.

§ 714. **T**O make a proper paste for this purpose, you must boil some
glue

glue in water, and when you have added a proportionable quantity of dissolved starch, let them be well mixed together over a moderate fire.—Then take a smooth and compact piece of linen and stretch it upon a table, that it may not warp or contract.

In laying down the plan great care must be taken that the air shall not get under it, and when once fixed it must remain in the same position till it is quite dry.

T H E E N D.





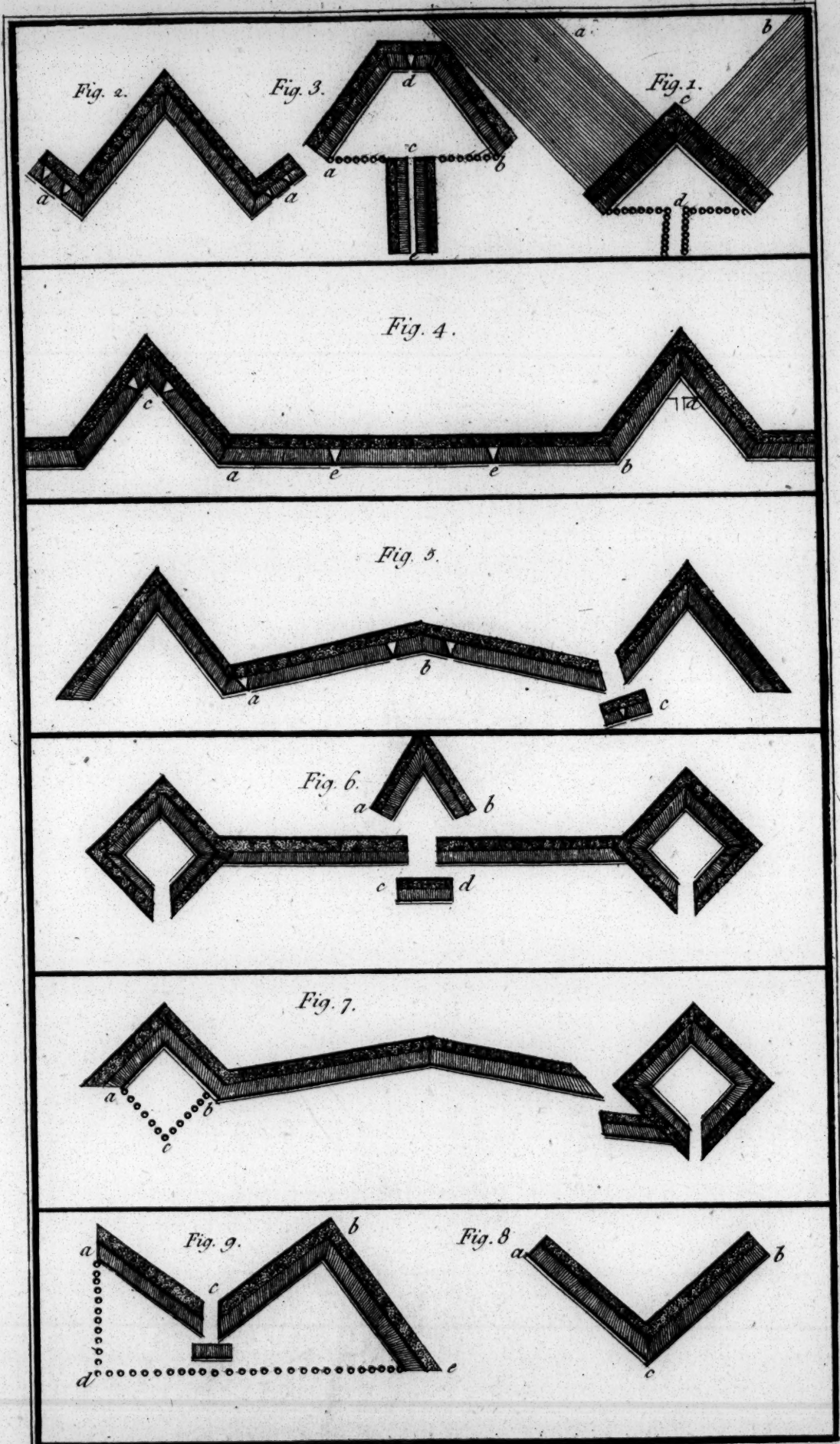
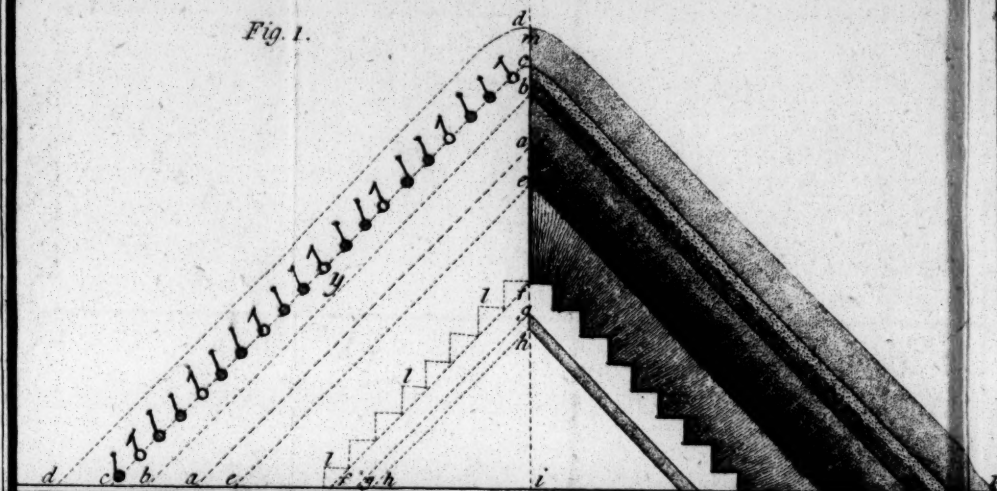
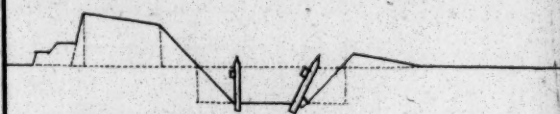


Fig. 1.



+ Fig. g.



+ Fig. h.

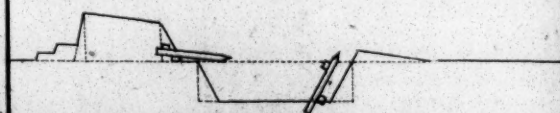
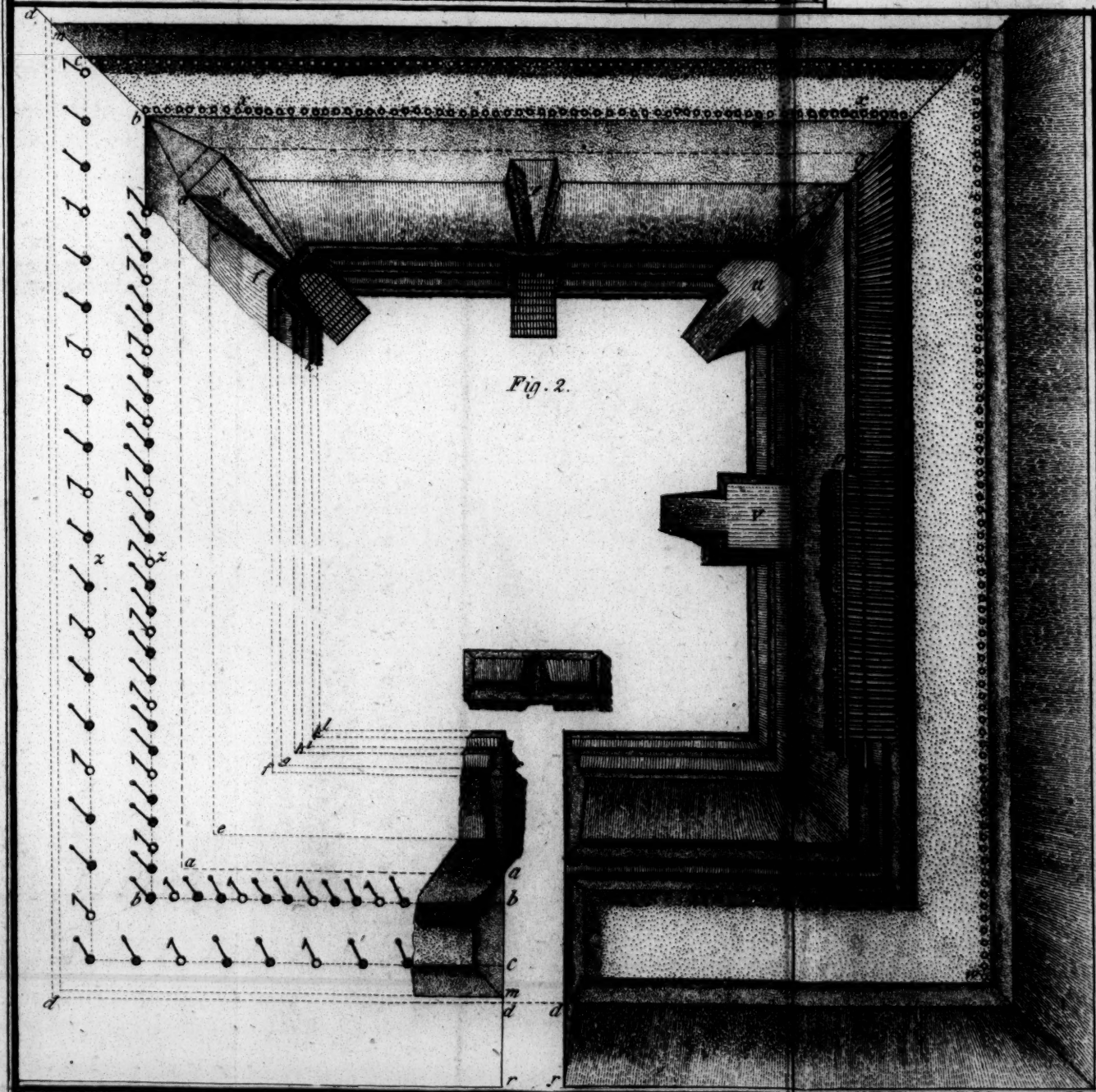
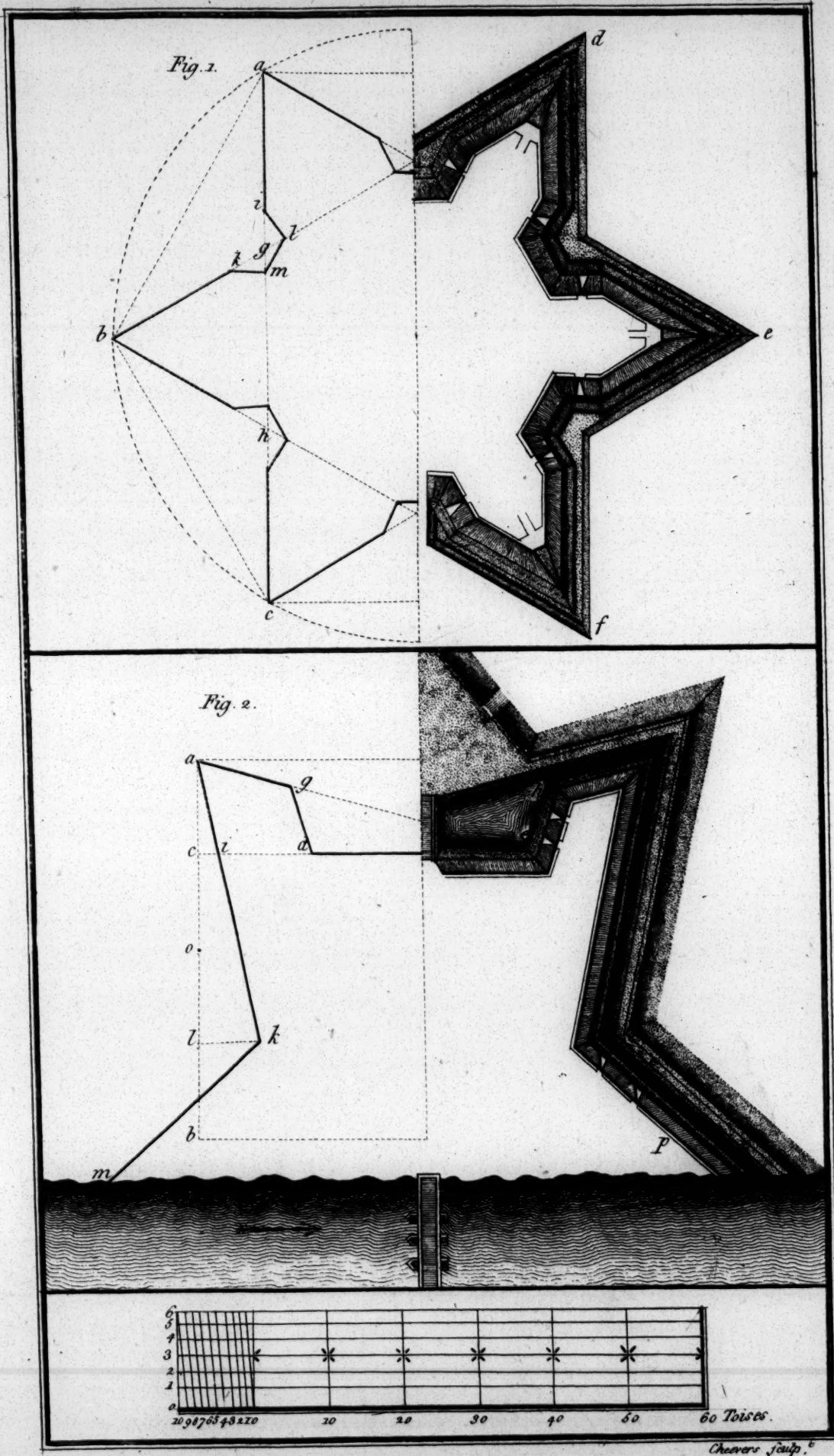


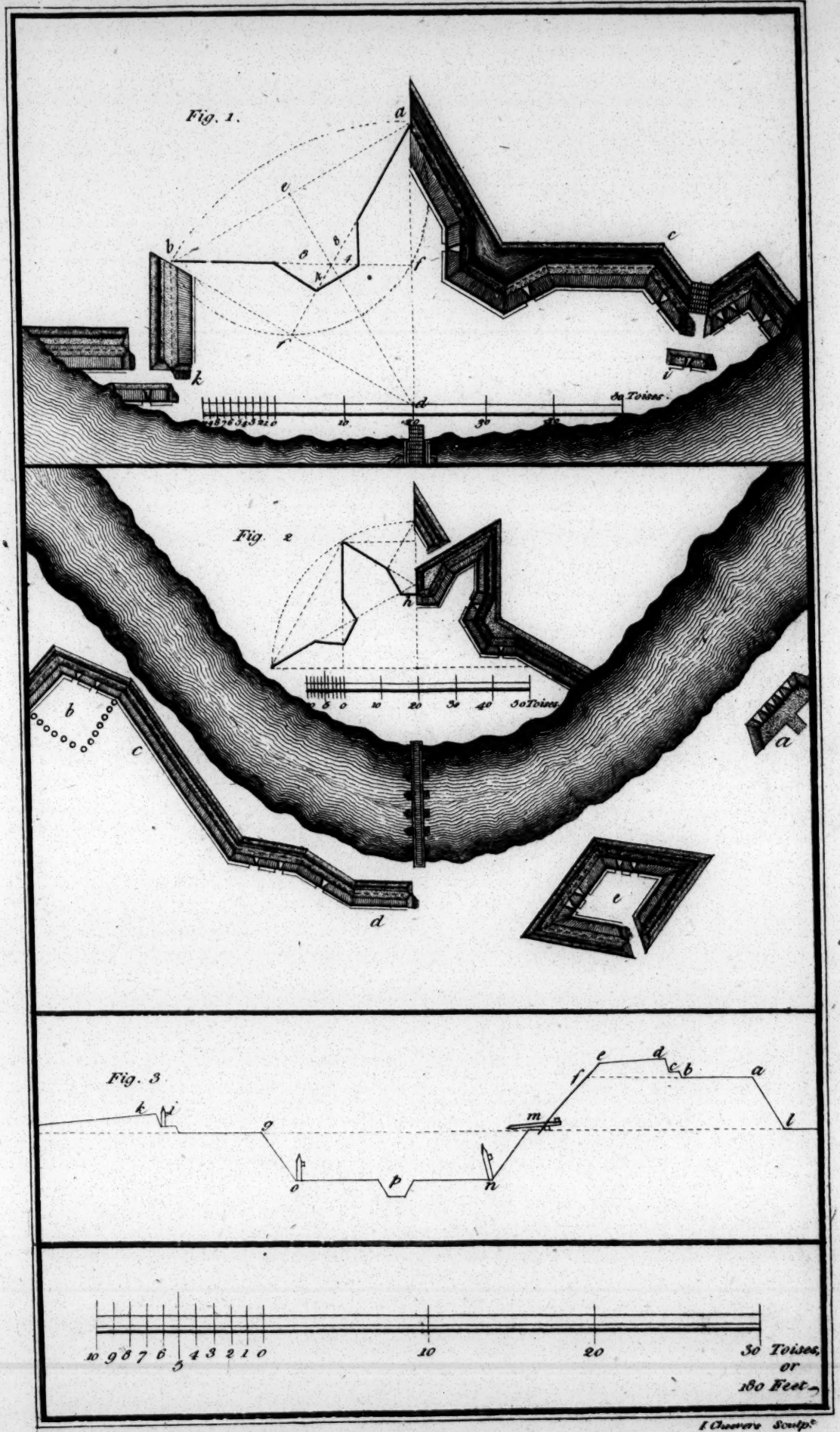
Fig. 2.

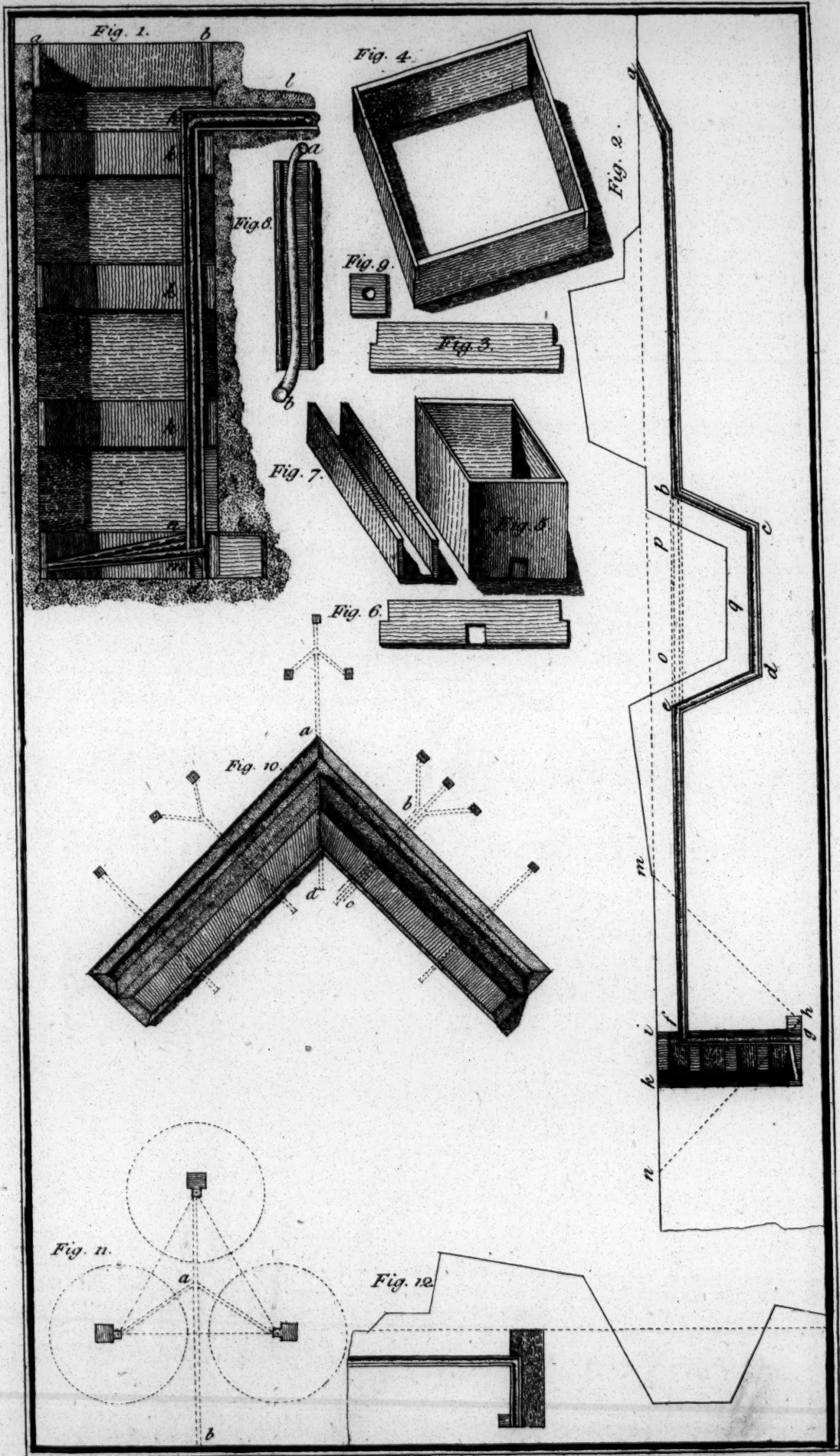


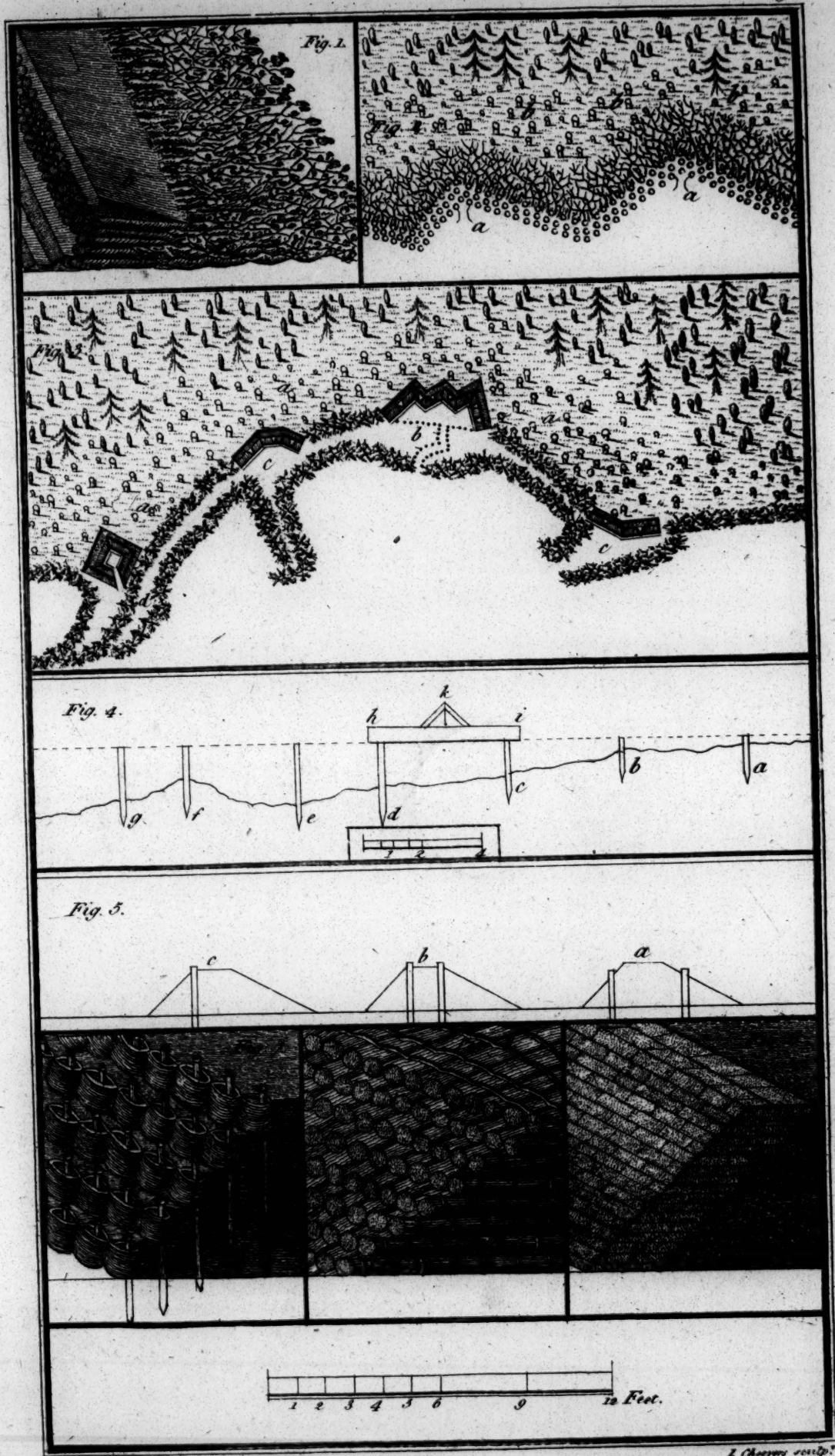
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Feet or 12 Lines.









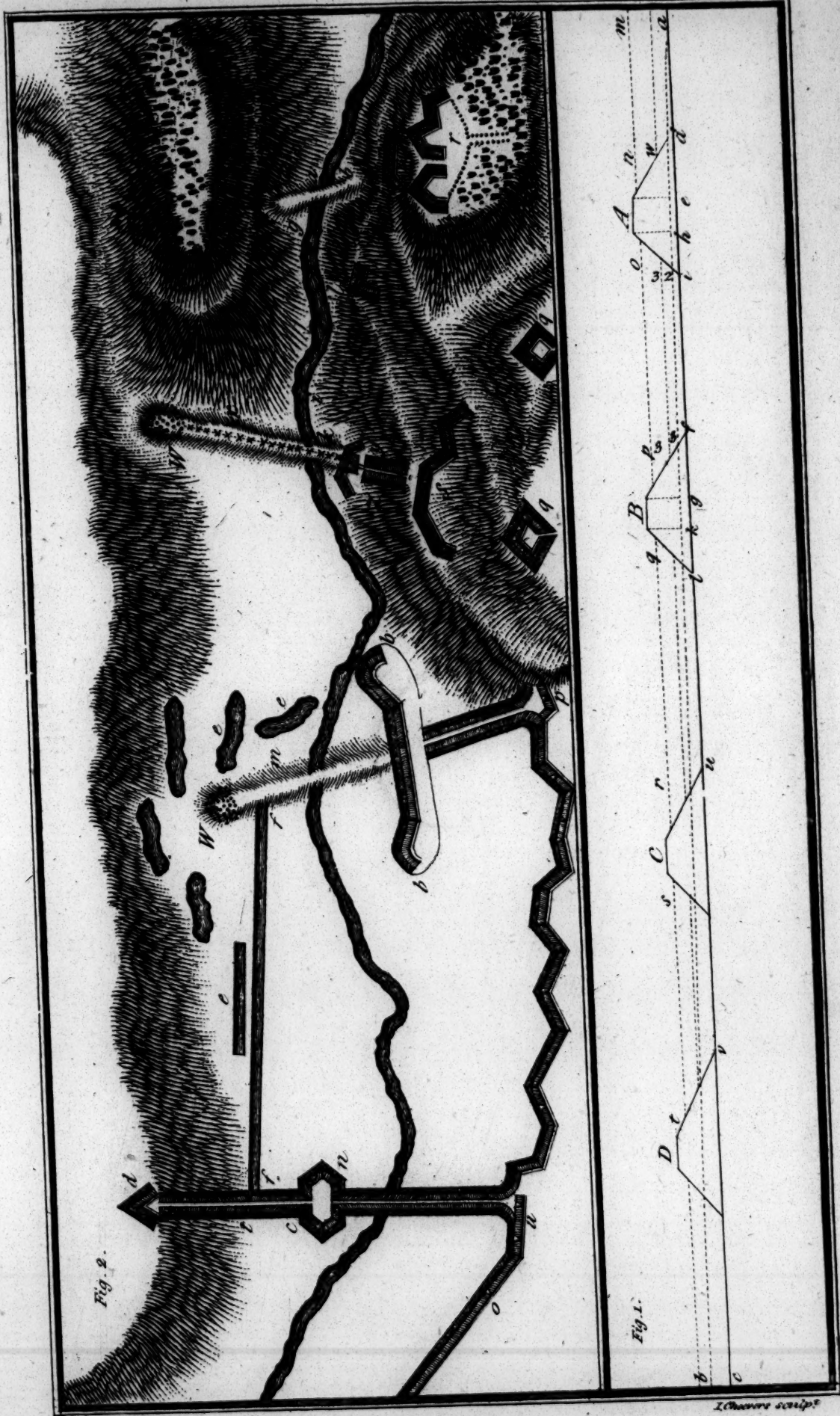


Fig. 1.

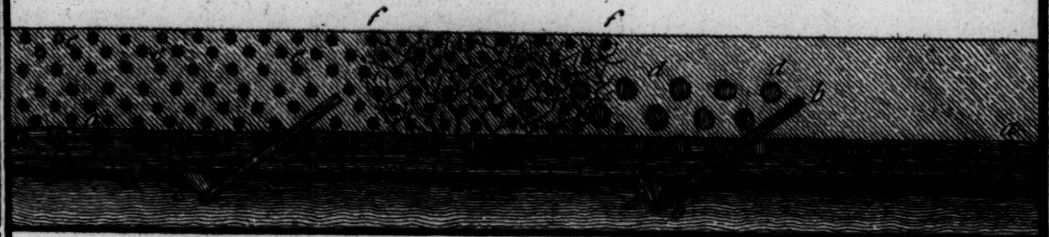


Fig. 2.

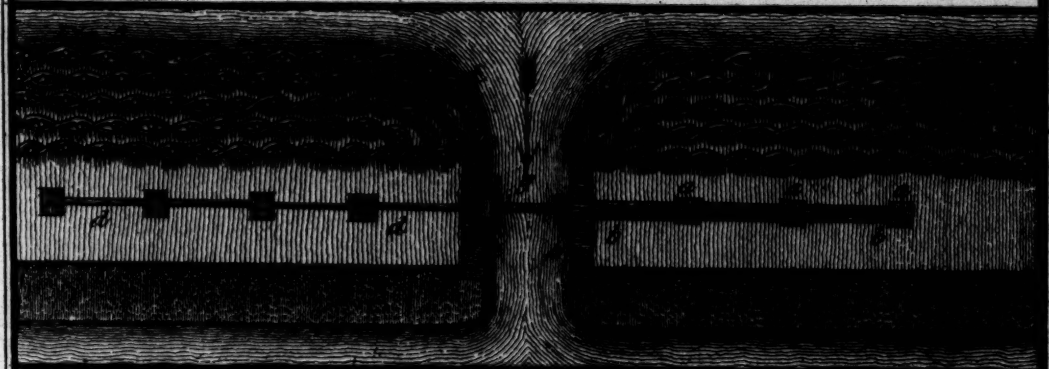
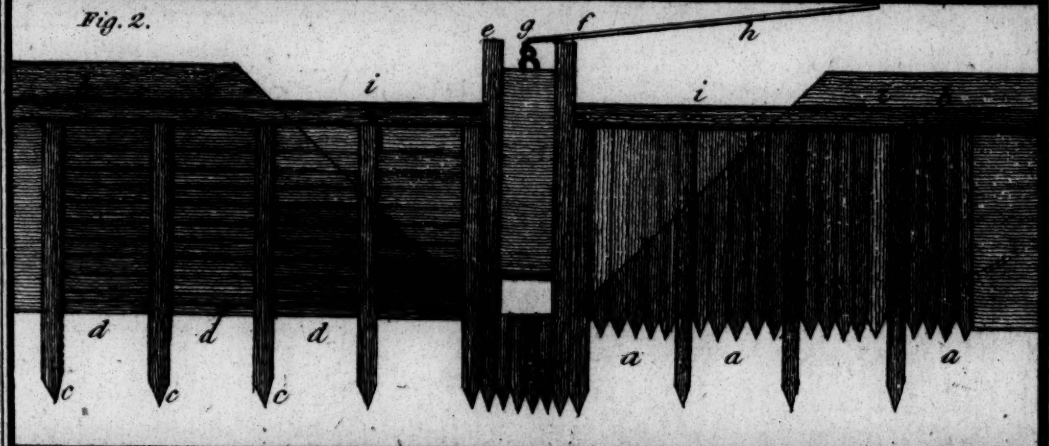


Fig. 4.

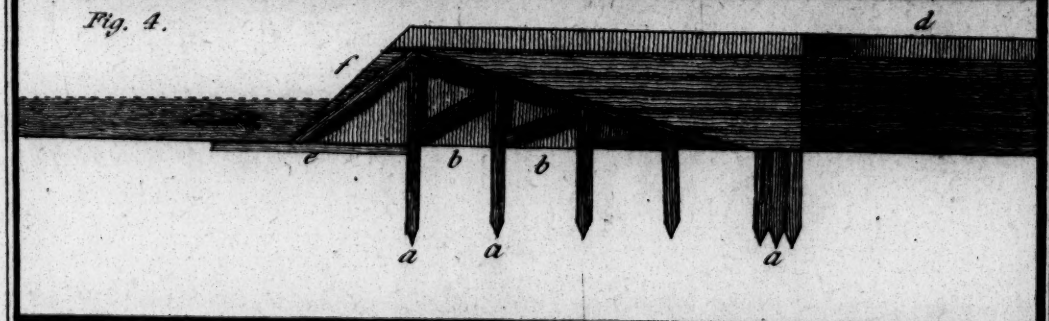


Fig. 5.

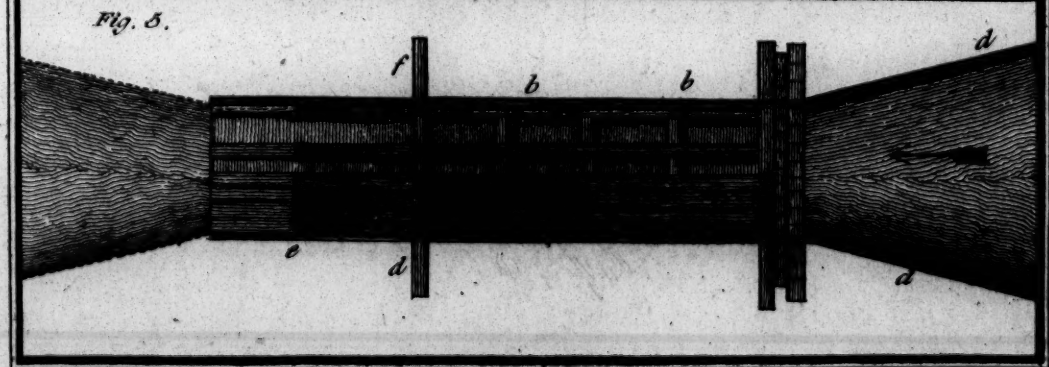


Fig. 1.

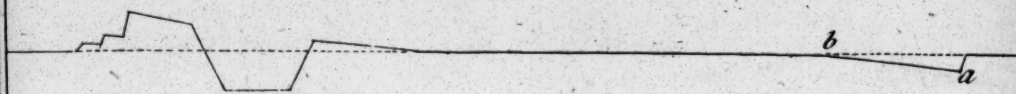


Fig. 2.

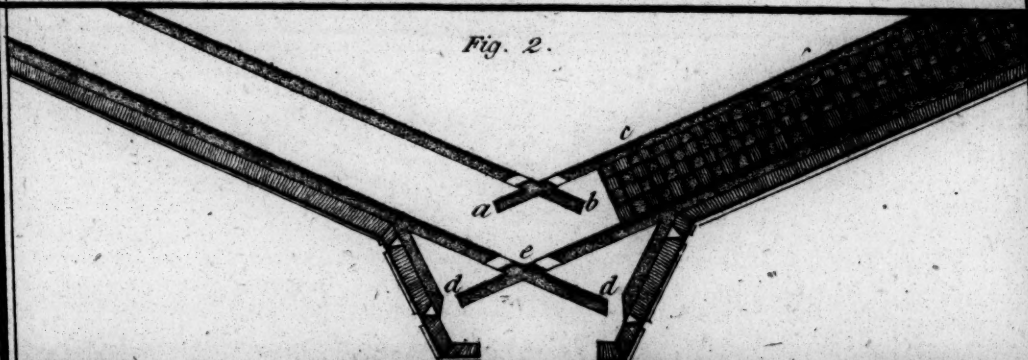
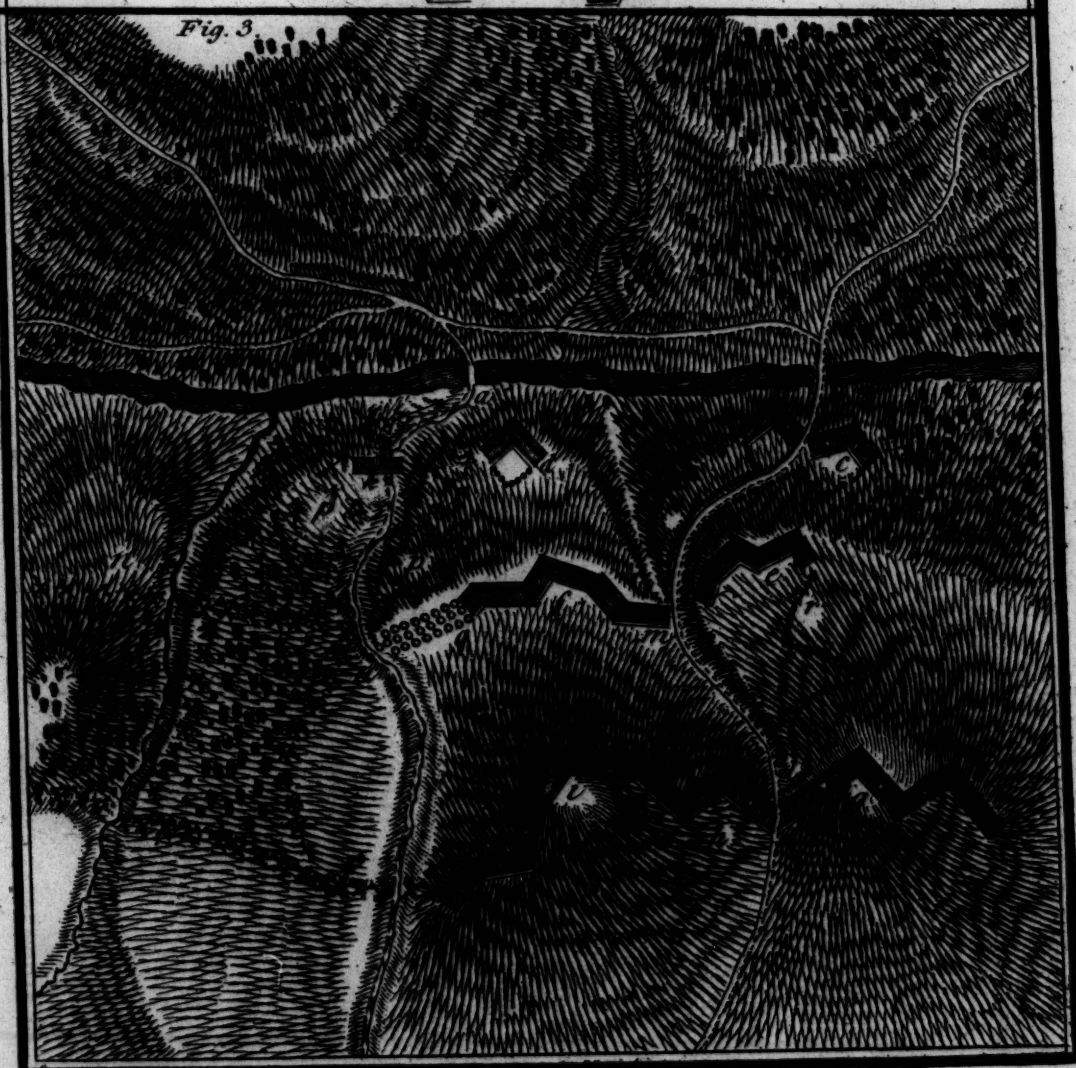


Fig. 3.



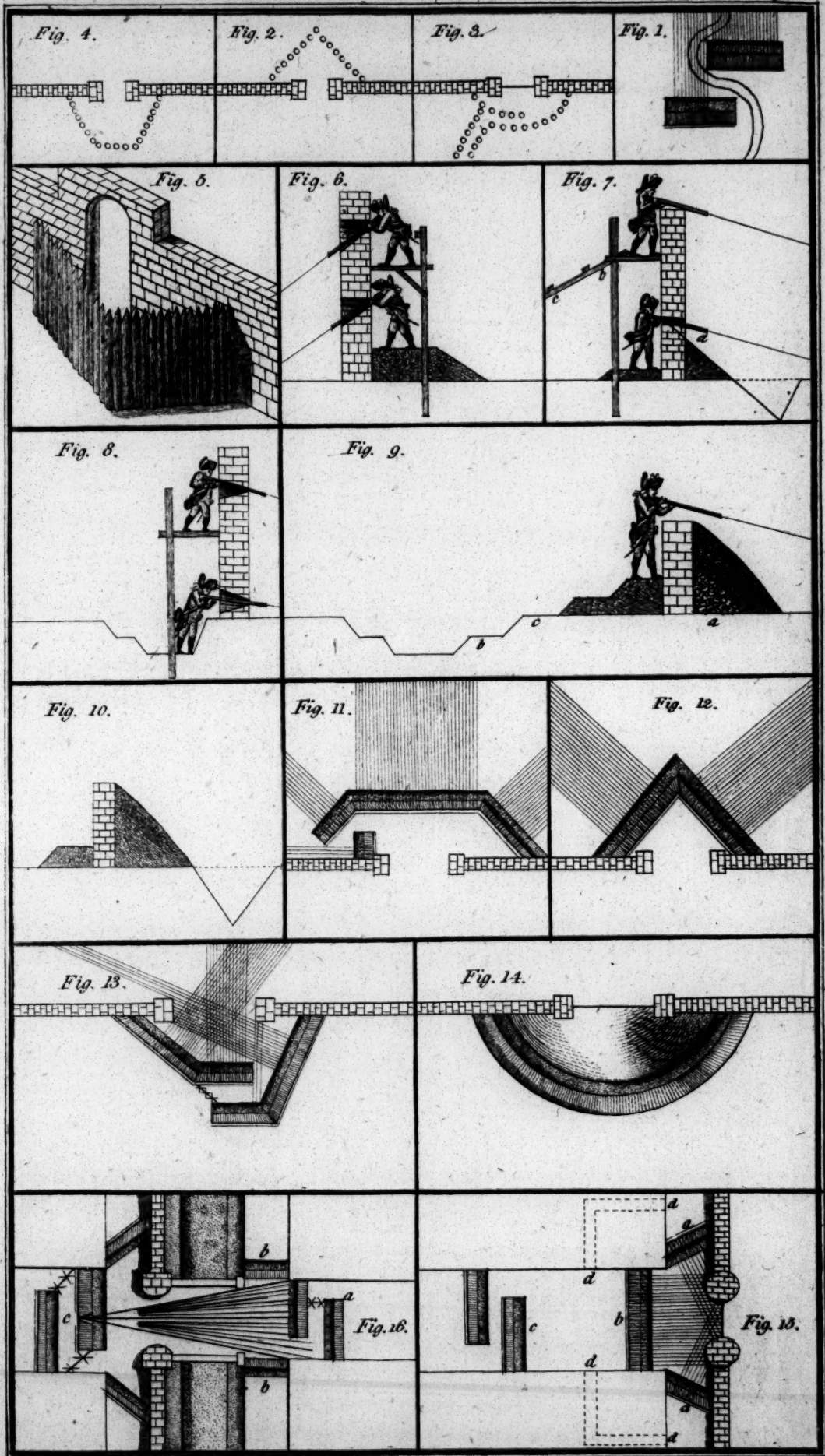


Fig. 1.

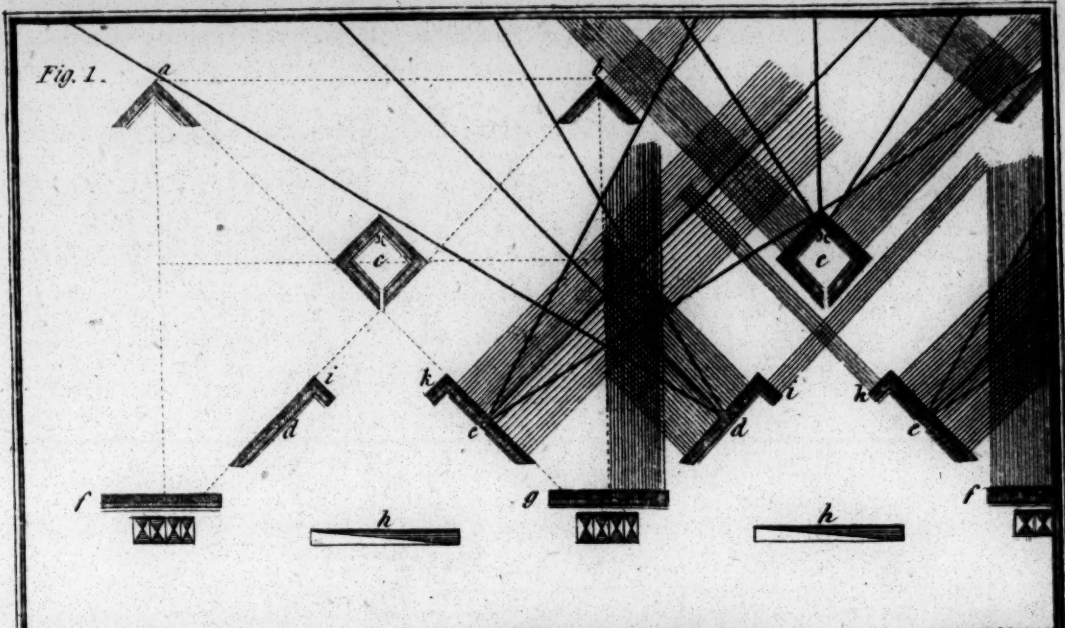


Fig. 2.

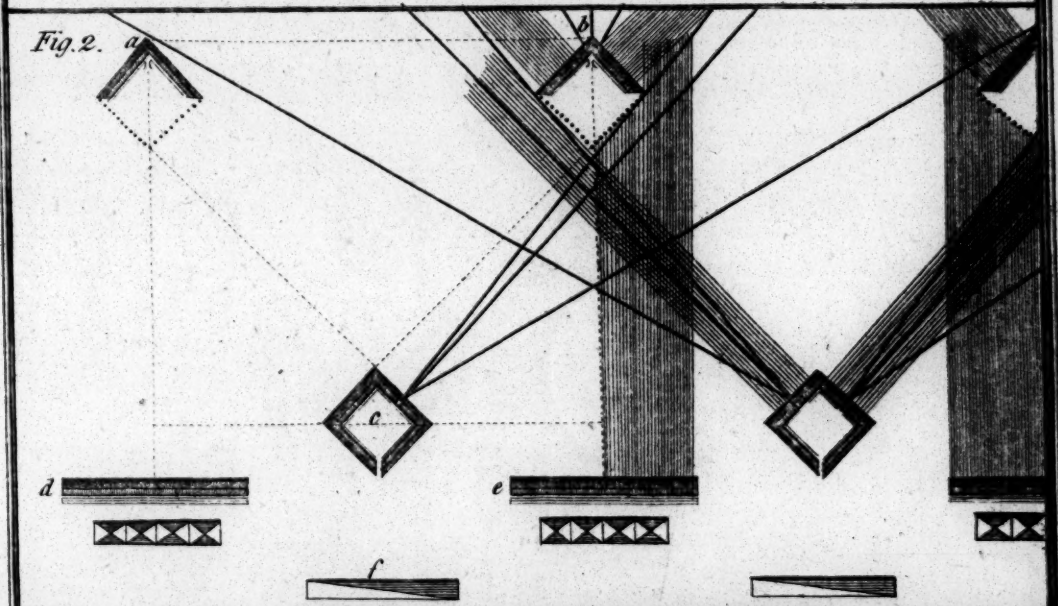


Fig. 3.

